CURRENT SCIENCE

Vol. X] MAY 1941 [No. 5

SIR P. C. RAY

IN order to commemorate the eightieth birthday of Sir P. C. Ray an appeal has been issued by eminent Indians belonging to all walks of life for a fund, which would be associated with his name and utilised for the promotion of scientific and industrial research. The appeal, which we are publishing elsewhere, recalls what the Indian nation owes to Sir P. C. Ray and we would on this happy occasion like to dwell briefly on his truly eventful life.

Born on August 2, 1861, in a village called Raruli in Bengal, Prafulla Chandra was nurtured in a cultured family and brought up for a few years on the country estate of his father, Haris Chandra Ray. In 1870, the family moved to Calcutta, and Prafulla Chandra received his early education at the well-known Hare School, and later at the Metropolitan College founded by the illustrious Iswar Chandra Vidyasagar. A Gilchrist Scholarship, which he won in a competitive examination, enabled him to proceed abroad in 1882 and work for his B.Sc. and D.Sc. degrees of Edinburgh University under Prof. Crum Brown. He secured the Hope Prize Scholarship, acted as a member of the staff and was also elected Vice-President of the University Chemical Society, of which Crum Brown was the President. Prominent among his fellow-students was James Walker, who later distinguished himself as a physical chemist. One striking event which throws considerable light on the burning patriotism and on the versatile talents of Prafulla Chandra was when he wrote his famous essay on India while still a student at Edinburgh. This, as is well known, brought the young Indian student a highly appreciative letter from John Bright, part of which was as follows: "There is an ignorance on

the part of the public in this country and great selfishness here and in India as to our true interests in India. The departures from morality and true statesmanship will bring about calamity and perhaps ruin, which our children may witness and deplore." It looks as if this might have been written yesterday!

Returning to India, Prafulla Chandra Ray joined Presidency College as an assistant professor in 1889 and found that Imperial Services were not meant for Indians, however talented they might be. His enthusiasm for research was, however, unbounded and it was at Presidency College that he began to infect his students with his enthusiasm for chemistry. He has been directly and indirectly the creator of that flourishing school of chemistry that we see in India to-day. Most of his later work was carried out at the University College of Science and Technology, which owes its origin to the genius of Sir Asutosh Mookerjee and the munificence of Sir Taraknath Palit and Sir Rashbehary Ghose. At the invitation of Sir Asutosh, Sir P. C. Ray joined the Palit Chair of Chemistry in 1916, which he held till a few years back. His scientific work has embraced varied fields in inorganic and organic chemistry and his monumental work on the "History of Hindu Chemistry" brought him a great tribute from that world-renowned savant Berthelot. The founding of the Indian Chemical Society was one of the products of his life-long scientific labour.

What is, however, noticeable in the career of Prafulla Chandra is a passionate love for India and his anxiety to make India modern, scientifically minded and industrialised. It is this urge that led him to his pioneering effort in founding the Bengal Chemical and Pharmaceutical Works, Ltd. Although Sir P. C. Ray has not only founded this firm but has helped its progress in every conceivable way, it is common knowledge that he himself refused to derive any financial benefit from it. It is up to this firm now to redeem its debt by contributing liberally to the fund for which the appeal has been issued.

As a philanthropist and a man whose heart goes out to his fellow-countrymen in every distress, Sir P. C. Ray needs no praise. His colossal efforts during the North Bengal Flood, his literally spending himself in order to help poor students and in order to support various organisations for social uplift are well known. In fact, when one reflects on the life of Sir P. C. Ray, one would find it difficult to find a parallel embodying in one personality his utter selflessness bordering on asceticism, his passionate devotion to science and learning in varied branches, his consuming love for his country and for the lowly and the poor, and his almost evangelical efforts to get this country out of the rut of obscurantism and superstition and put it on the road of science and industry. There is indeed hardly any aspect of India's national renaissance that does not bear the indelible impress of Sir P. C. Ray's leadership and untiring work. It is a matter of pride for any nation to be able to honour such a man and we would heartily endorse the appeal which seeks to perpetuate his eightieth birthday by raising funds for the promotion of scientific and industrial research, which has been the central love of his life.

THE QUANTUM THEORY OF X-RAY REFLECTION

BY

SIR C. V. RAMAN AND DR. P. NILAKANTAN

IN an article in *Current Science* for April 1940 under the title of "A New X-ray Effect", we drew attention to the remarkable features noticeable in a strongly exposed Laue diagram obtained with a cleavage plate of diamond when the X-ray pencil from a copper-target tube passes through the crystal approximately along the trigonal axis. Having convinced ourselves that the features we observed and described lay outside the scope of the classical X-ray optics, we put forward an explanation of the phenomena on novel lines. Basing ourselves on the accepted principles of the quantum theory of radiation, we showed that the lattice planes in a crystal should be capable of giving two kinds of geometric reflection of X-rays; besides the classical or Laue reflections, modified or quantum reflections are also possible which have their origin in the *quantum-mechanical* excitation of the *optical* vibrations of the crystal lattice. The geometric law of the quantum reflection stands in the same relation to the dynamic stratifications of electron density associated with such vibrations of the lattice that the classical reflections have in relation to the static structure amplitudes of the crystal. The investigations we have made during the past twelve months have completely confirmed the views expressed by us in the article referred to. It is our purpose in the present communication to indicate how such confirmation has been reached, and briefly to present the new ideas regarding the dynamics of crystal vibrations of the optical class to which we have been led by our X-ray studies.

The nearest approach to our point of view to be found in the classical literature is a memoir by Laue in the *Annalen Der Physik* for December 1926, in which he subjects the work of Debye, Faxen and Waller on the problem of the scattering of X-rays in crystals to a critical review and treats it afresh on original lines. Laue explicitly restricts himself to those modes of vibration of the crystal lattice which do not involve relative displacements of the atoms in the unit cell, in other words, to the elastic modes of vibration. His most striking result is that the scattering of X-rays occurs in every case with a change of frequency equal to that of the mechanical vibration of the crystal. He further shows that for elastic vibrations of any specified wave-length and orientation to be effective, the usual Laue conditions must be satisfied with respect to a spacing found by a vectorial combination of the reciprocals of a given lattice spacing and the given wave-length. Laue's investigation thus indicates, in the language of the quantum theory, that the scattering of X-rays by the elastic waves also involves an exchange of momentum and energy between the photon and the crystal. The geometric conditions for such scattering are formally analogous to those for a dynamic reflection. But fundamental differences between the cases of the acoustic and the optical vibrations of the crystal lattice emerge as soon we enter into a closer consideration of the problem.

At a very early stage of our investigations, we considered the question whether the modified reflections observed by us in diamond and other crystals could possibly be explained in terms of the thermal scattering of X-rays by the elastic waves, and came to the conclusion that this was quite impossible. Indeed, Laue himself remarks towards the end of his paper that no noticeable concentrations of intensity in any direction could be expected as the result of X-ray scattering. As some X-ray workers (Lonsdale, Zachariasen) have expressed a different opinion in the recent literature of the subject, it would appear worthwhile to explain why it cannot be correct. The essential feature of the acoustical vibrations of the lattice is that the waves have all possible lengths and orientations, subject to the restriction that the total number of such waves is 3 N, N being the number of lattice cells in the crystal. This restriction is automatically secured when, following Born, we set out the reciprocals of the wave-vector in a three-dimensional space. The reciprocal points then appear uniformly distributed in the "phase-space". Actually, when the finite resolving-power of the crystal considered as an optical grating is taken into account, these discrete points are "smudged"

out just sufficiently to make the "phase-space" just a uniform continuum within which the terminus of the reciprocal wave-vector must lie. It is obvious that in these circumstances, the scattering of the X-rays cannot give rise to any phenomenon even distantly approaching the character of a geometrical reflection. Further, the intensity of the scattering in any specified direction being proportional to N, its intensity would be quite negligible in relation to the intensity of the classical reflection which is proportional to N^2, provided the volume of the irradiated crystal is sufficiently small. In actual experience, however, the modified reflections by the (111) planes in diamond continue to be recorded even when the volume scattering by the crystal is made negligibly small by using a fine X-ray pencil and the edge of a thin plate to obtain the reflection.

The considerations stated are sufficient to show that the observed effects are not due to X-ray "scattering". It is worthwhile, however, to go rather more deeply into the matter. The believers in the "scattering" theory place their reliance on the fact that the expression for its intensity contains a factor proportional to the square of the wave-length of the elastic waves. This factor undoubtedly becomes important when the elastic wave-lengths are great. But it is just at this stage that the scattering coincides in direction with a classical reflection and is therefore wholly unobservable. When the crystal setting is altered even by a degree of arc, the numerical factor ceases to be important, and instead of a "peak" the theory indicates only a "hump" in the scattering intensity curve which becomes rapidly less pronounced as the crystal is moved away from the correct setting for a monochromatic reflection. The actual experimental observations with the (111) reflections of diamond reveal a very different state of affairs. As can be seen from Fig. 1, the modified reflections persist with undiminished sharpness over a wide range of settings of the crystal.

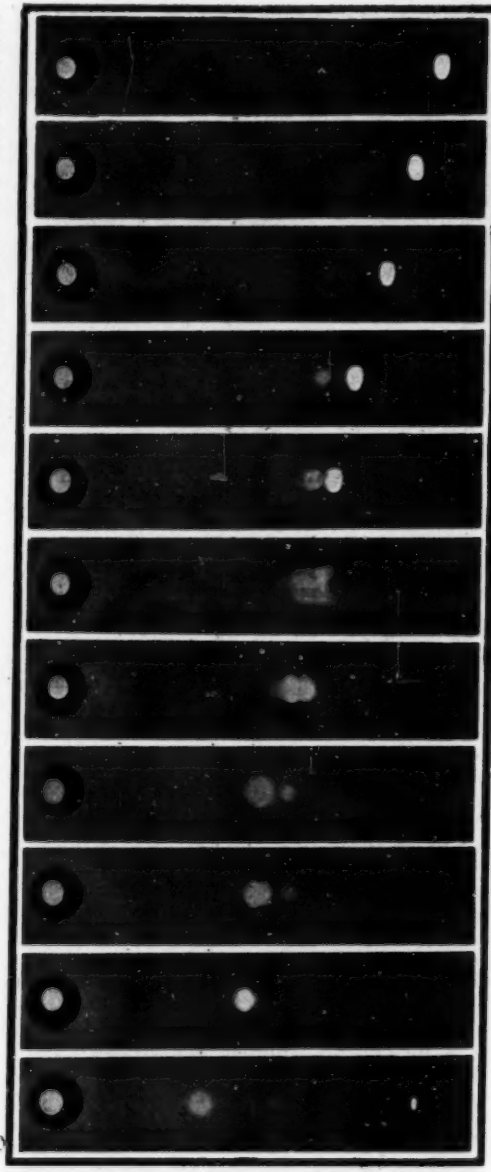


FIG. 1. The Modified Reflection by the (111) planes of a diamond crystal at various settings with copper Kα and Kβ X-rays

A crucial test of the whole question is furnished by our low-temperature experiments with diamond. As already mentioned, a change of frequency, in other words, a transition between the different energy levels in the crystal is involved in either case. On the "scattering" theory, we are dealing with elastic waves of relatively great wave-length and low frequency. Indeed, the nearer the direction of scattering is to that of the classical reflection, the longer would be the effective wave-length and the lower the frequency of the

vibrations. Transitions between such low frequency levels are necessarily determined with all desirable accuracy by the classical dynamics. In other words, the intensity of the X-ray scattering should diminish in proportion to the absolute temperature. The case of diamond is specially suitable for such a test, because in respect of elastic waves of the length effective at small angles of scattering, $h\nu^* \ll kT$, while for the optical vibrations $h\nu^* \gg kT$. The necessary experimental tests have been tried out by us and fully confirm the prediction published in May 1940. They show that the modified reflections by the (111) planes in diamond appear with sensibly unaltered intensity when the crystal is cooled down to liquid air temperature, and that is the case, irrespective of the crystal setting employed. The observations clearly indicate that $h\nu^* \gg kT$, in other words, that the modified reflections are due to the *optical* vibrations of the lattice, and not the acoustic ones. They also demonstrate that the modified reflection is a quantum-mechanical effect.

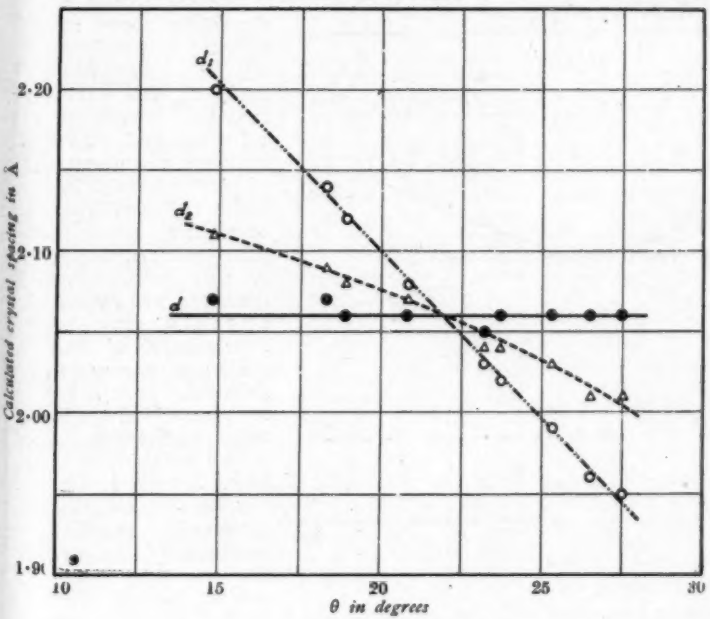


FIG. 2

Showing the failure of the Faxen formula for the (111) reflections by diamond

While the elastic vibrations of the lattice correspond to the three translatory movements of the lattice cells, the optical vibrations represent all the remaining degrees of freedom of atomic movement, and are best regarded as oscillations of the interpenetrating lattices in the crystal with respect to one another. In all actual crystals, the number of such possible vibrations is comparable with and indeed in many crystals very much greater than the number of the acoustic degrees of freedom. As is very clearly shown by spectroscopic studies of light scattering in crystals, these optical vibrations may often be of quite low frequency and are therefore powerfully excited by the thermal agitation of the crystal. Even considered from the purely classical point of view, therefore, the optical vibrations of the lattice must play an extremely important part in X-ray optics. There is ample evidence that this is actually the case and that the modified reflection of X-rays is directly associated with such optical vibrations. To mention only one instance, we may refer to our published results on the special behaviour of the classical and modified reflections by the (210) planes in sodium nitrate and their relation to the thermal excitation of the rotational oscillations of the NO_3 ions in the crystal.

An oscillation of the interpenetrating lattices in the crystal with reference to one another alters the structure amplitudes of the unit cells without appreciably displacing them from their positions in the ordered arrangement of the crystal. Such oscillation is therefore capable of giving rise to geometric reflections by the crystal planes with an intensity proportional to N^2 and to the square of the periodic variation of structure amplitude produced by such oscillation. Since the atomic vibrations in the different cells are of identical frequency and are mechanically coupled to each other, they are necessarily in coherent phase-relationship with

FIG. 1. The Modified Reflection by the (111) planes of a diamond crystal at various settings with copper Kα and Kβ X-rays

each other. It is readily shown that for a modified reflection to be observable in any specified direction, the usual Laue condition must be satisfied by the dynamic spacing obtained by a vectorial combination of the reciprocals of the crystal spacing and of the phase wave-length of the optical oscillations in the crystal. To find the directions in which the modified reflections appear, we proceed to set out the reciprocal wave-vectors for the particular optical vibration in a three-dimensional diagram. It is at this point that the fundamental difference between the acoustical and optical modes of the vibration of the lattice emerges. As we have already seen, such a diagram for the elastic waves is effectively a continuum which is everywhere of uniform density. If this were also true for the diagram in the optical case, there would be no possibility of explaining the actually observed reflections. We are obliged therefore to conclude that *the Born diagram correctly represents only the acoustic "phase-space" and has no application or significance with respect to the optical "phase-space".*

ing the oscillations of the lattice is purely geometrical in spirit and is essentially only a refinement of the well-known Rayleigh-Jeans method, and its physical content must therefore be the same. In other words, its validity is restricted to the enumeration of the acoustic vibrations. The optical vibrations of the lattice, on the other hand, may be regarded as analogous to the specific vibrations of a molecule of giant size, and there is no logical reason that one can discover for assuming that the reciprocal phase wave-lengths for the oscillations of such a molecule when represented geometrically should fill space with uniform density. On the contrary, it is reasonable to assume that the possible orientations of the phase-waves are of a highly restricted character and have a specific relation to the symmetry characters of the crystal and of the particular mode of vibration involved. Accepting this idea, we realise immediately that intense and highly localised modified X-ray reflections become possible when oscillations with such a character are excited.

A convincing proof of the correctness of the ideas above set forward is furnished by a quantitative study of the (111) modified reflections of diamond for various orientations of the crystal, the plane of incidence coinciding with a plane of symmetry. A full account of the work will appear shortly in the *Proceedings of the Indian Academy of Sciences*. It will be sufficient here to refer to the results shown graphically in Figs. 2 and 3. In Fig. 2, the actually observed angular positions of the reflections are represented against the crystal spacings as calculated from three different formulæ.

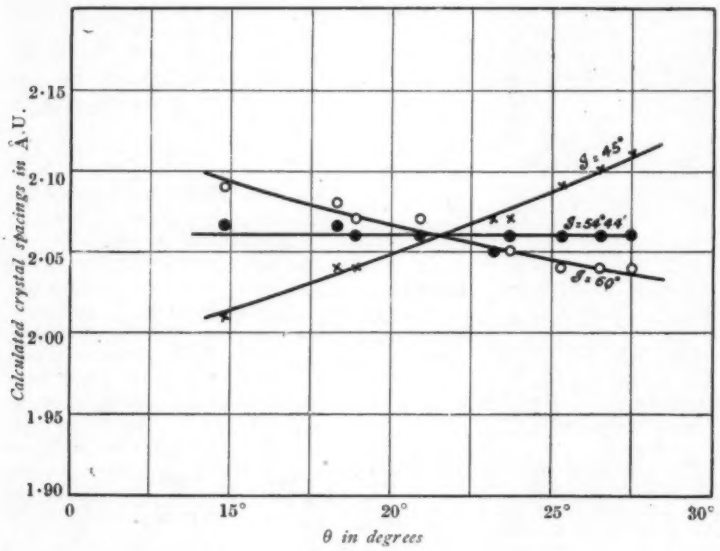


FIG. 3

Determination of the Inclination of Phase-Waves to the (111) Crystal Spacings in Diamond

The conclusion stated above cannot be regarded as in any way incredible or even surprising. The Born method of enumerat-

The graph marked d_1 assumes that the phase-waves are normal to the static crystal-spacing. The graph marked d_2 is a curved

line which represents the crystal spacing calculated from the Faxen formula. The graph marked *d* is calculated on the assumption that the phase-waves, are inclined to the (111) planes at a constant angle of 54° 44′ which is half the tetrahedral valence angle, in other words parallel to the (100) planes transverse to the plane of incidence. It will be seen from the figure that the third graph is a horizontal straight line and gives a constant spacing very close to the actual one, namely 2·055 A.U.

In order to exhibit how closely the observed inclination of the phase-waves may be determined from the observed data, Fig. 2 shows the crystal spacing worked out for three different values of the angle, namely 45°, 54° 44′ and 60°. It is evident that if the graph is to be a horizontal line, the angle cannot differ from half the tetrahedral valence angle by more than 1° either way. It is thus clear that the Faxen formula is wholly irrelevant to the present problem and that the modified reflections arise from the fact that the phase-waves of the optical vibration have a precisely determined orientation and azimuth with reference to the crystal planes. Further striking confirmation of these conclusions is afforded by the observations of fainter reflections by the phase-waves parallel to the two other (100) planes inclined to the plane of incidence, and by the effect of inclining the plane of incidence to the plane of symmetry. Into these details we need not here enter.

THE SULPHUR POSITION IN INDIA

BY

SIR S. S. BHATNAGAR, Kt., O.B.E., D.Sc., F.Inst.P., F.I.C.

IT is not necessary to enumerate the numerous uses of sulphur. Sulphur and sulphuric acid are indispensable to any country not only for the production of war-time requirements, but also for the needs of all important industries even during peace-time.

It is well known that all sulphur used in India and Burma is imported. Essential supplies cannot be obtained from within the Empire. The quantities in tons of sulphur imported during recent years and the sources from which the supplies were obtained are shown in the following table:

It is obvious from the table that the principal importing countries before the outbreak of war were Italy, Japan, Java and the United States of America.

The rapidity with which the European conflagration is spreading and the threats of war from our eastern neighbours have brought the sulphur problem in India to the forefront and both the Government and the public outside have studied the subject with more than usual enthusiasm and concern. In the second meeting of the Board of Scientific and Industrial Research held in Simla on the 12th and 13th June 1940,

	1933–34	1934–35	1935–36	1936–37	1937–38 (Excluding Burma)
British Empire	69	89	29	55	145
Germany	1,604	492	2,108	918	177
Italy	12,258	10,680	9,226	9,472	18,363
Java	2,091	2,448	1,643	1,837	991
Japan	4,856	5,945	12,376	11,742	9,221
U.S.A.	1,286	541	591	1,729	380
Other countries	10	53	25	1,780	131
Total all countries	22,174	20,221	26,099	27,539	29,408

Note.—The estimated value of the 29,408 tons imported in 1937–38 was Rs. 25,95,206 or approximately Rs. 90 per ton. The present price is approximately Rs. 150 per ton.

Brigadier Wood of the Supply Department emphasised the fact that the most important material which constituted a real shortage from the point of view of supplies was sulphur and the Board decided to constitute the following committee to study the sulphur problem in India from all points of view:

Sulphur Committee.—S. S. Bhatnagar (*Chairman*), Cyril S. Fox, J. C. Ghosh and H. Krall (subsequently added on Chairman's recommendation).

In the earlier stages, the Committee examined the sulphur question from the following points of view:

(1) From the view-point of existing methods of the recovery of sulphur from sulphur-bearing salts and minerals available in abundance in this country.

(2) From the view-point that the described and the talked of, but probably available sources of natural sulphur and sulphur-bearing minerals, may be examined again with a view to seeing if the likely supplies are expected to be larger than previously estimated. and

(3) From the point of view of manufacturing or extracting sulphur compounds useful in trade from natural sources such as coal, oil, etc., which have been reported to be sufficiently rich in sulphur content.

As the functions of the Board of Scientific and Industrial Research are to finance those investigations which may lead to some tangible practical results by research, all items under (1) were to be examined from the economic point of view only, but attention was to be particularly bestowed upon (2) and (3) which required research.

As regards (1), particular attention was given to the subject of the recovery of sulphur from coke-oven gases, smelter gases such as those of the Indian Copper Corporation and the Burma Corporation and the utilisation of the deposits of gypsum for the production of sulphur. Various processes have been worked out in industrial countries to carry out one or other of these operations and particular mention has been made in this connection of the "Thylox" process, the "I.C.I./Bolidens" process, the "Orkla" process and others.

Thylox Process.—This process has been developed from the non-recovery Seaboard Process in Germany and the United States where it is widely employed for the treatment of domestic gas supplies for the removal of hydrogen sulphide and recovery of sulphur from coke-oven gases. In this process the hydrogen sulphide is removed by scrubbing the gas with an absorbing solution consisting of certain alkali metal compounds of arsenic, such as sodium or ammonium thioarsenate and is recovered to sulphur on oxidation by air. These reactions are fairly represented by the following equation:

$$Na_3AsO_2S_2 + H_2S = Na_3AsOS_3 + H_2O$$
$$Na_3AsOS_3 + O = Na_3AsO_2S_2 + S.$$

The solution remains uncontaminated by other substances in the gases both during treatment of the gas and also during regeneration of the foul solution. As a result, the sulphur filtered from the solution is not contaminated by other substances and is so pure that it can be sold both as sulphur and as an agricultural fungicide.

The Thylox process, or one or other of its alternative developments, such as the Ferrox, Nickel, Phosphate, and Phenolate processes, is now in general use for the removal and recovery of sulphur from various kinds of fuel gases, including coke-oven gas, blue-water gas, carburetted water gas, and oil refinery gases. These processes are best adapted to dealing with fuel gases at ordinary pressure which contain small or moderate quantities of hydrogen sulphide. The newest type of Thylox plant consists of a tower absorber, through which the gases pass and are scrubbed during transit by means of the solution, an aerating tower in which the foul solution is aerated thereby effecting liberation and flotation of the sulphur, a sulphur slurry tank, and a continuous filter for the removal of the sulphur. The whole plant occupies very little ground space. A heater or other means of warming the solution is unusually provided so as to heat the solution entering the aerating tower up to about 95° F., which is the best temperature for effecting the oxidation reaction. About 98 per cent. of the hydrogen sulphide content of the gas can be removed by this process. Pointed attention of the Tata Iron and Steel Company, Jamshedpur, was drawn to the advantage which would accrue if they adopted this process, and they promised to consider the whole question.

I.C.I./Bolidens Method.—A company named Messrs. Sulphur Patents Ltd., London, was formed within recent years by Messrs.

Imperial Chemical Industries Ltd., and a Swedish firm, Messrs. Boildens Gruvaktiebolag, for the recovery of sulphur from smelter gases produced when smelting ores similar to those occurring in India and Burma. The Swedish firm had developed a process for the direct production of sulphur from smelter gases and had operated a plant for several years at their mine in Sweden with a production capacity of up to 70 tons of sulphur per day. During the same period Messrs. Imperial Chemical Industries had developed a process for the production of concentrated sulphur dioxide from weak gas by using an absorbing solution of basic aluminium sulphate. In view of the complementary nature of these processes, an agreement was arrived at in 1936 whereby the patents and processes of the two companies were pooled and the company under the name of Messrs. Sulphur Patents Ltd., was formed to act as sole agents to negotiate licenses for the processes owned by the two companies.

About the same time Messrs. Chemische Industries, Basle (Ciba), had also devised a process for concentrating sulphur dioxide, and this firm entered into an agreement with the Metallgesellschaft of Frankfurt, under which this process was to be developed, and Messrs. Lurgi Chemie (a wholly owned subsidiary of Metallgesellschaft) worked out a process for the production of sulphur from such concentrated sulphur dioxide. For some time these two groups, *viz.*, I.C.I./Bolidens and Lurgi/Ciba worked in competition in regard to developments in the field of concentration of SO_2 and its reduction to sulphur. Subsequently, however, the four companies pooled their patents and processes, with the result that the best process or combination of processes could be applied to each particular problem. In view of the fact that the Lurgi Chemie was a company whose specific object was the design and construction of chemical plants, the members of the pool agreed that the exploitation of the patents and processes should be placed in the hands of Lurgi Gasellschaft fur Chemie und Huttenwesen, m.b.H., Lurgihaus, Gervinusstr 17/19, Frankfurt A.M., Germany.

A branch of this firm, the American Lurgi Corporation, New York, is operating in America, but it may be assumed that Messrs. Sulphur Patents Ltd., have taken over activities connected with these developments.

Negotiations were conducted some time ago between Messrs. The Indian Copper Corporation and Messrs. Sulphur Products Ltd., with a view to investigating the economic possibilities of recovering sulphur from their smelter gases, as it was anticipated that if only a 50 per cent. yield were obtained, about 3,500 tons of sulphur might be available annually from the Singhbaum plant. These negotiations were unsuccessful, however, owing, it is understood, to the Corporation being doubtful whether the gases obtained in their present process of production could be economically utilised and also to their not being disposed to incur the considerable expenses which would be involved in installing the necessary plant. The position was examined recently once again, but the costs and patent positions are prohibitive.

It may be mentioned in this connection that the tonnage of raw material with which the Burma corporation deals is much greater than that treated by the Indian Copper Corporation, but smelting operations, with the exception of lead and silver, have not hitherto been carried so far as the extraction of the metals. Copper and nickel ores received a preliminary concentration to a matte (mainly the sulphides) and speiss (largely arsenides) respectively by means of smelting, and the matte and speiss were subsequently shipped to Germany where the extraction of the metals was carried out. Zinc sulphide was concentrated by ore dressing methods, the "concentrates" being then shipped to Belgium for smelting.

A large amount of sulphur dioxide is produced in the course of these operations and it might be quite feasible to recover sulphur from this and the Burmese Government may well direct their attention to the recovery of sulphur from these gases.

Reference has been made above to the utilisation of gypsum for the production of sulphur. The best known method of recovering sulphur or sulphuric acid from gypsum which has been developed commercially consists in their production from a sintered mixture of powdered gypsum (calcium sulphate) clay, and coal or coke. A process based on this method is operated by the Bayer organisation at Lever Kusen, Cologne, and more recently by Messrs. Imperial Chemical Industries Ltd., at Billingham, Yorkshire.

The process adopted by the former firm

consists in heating a mixture of powdered anhydride or waste calcium sulphate with powdered coal or coke and shales or clay at 800° in a rotary kiln in an oxidising atmosphere. The kilns are 164 ft. long by 10 ft. diameter and are fired by means of pulverised coal. The burner end is cooled by water drips. The object of the oxidising atmosphere is to prevent the formation of carbon oxysulphide in the gases and of calcium sulphide in the clinker. The gases, which contain 6–7 per cent. SO_2, are freed from dust by electrical deposition, washed, and sent to the chamber or contact plant. The kiln residue is ground up with blast furnace slag and marketed as cement. A description of this process is given in the *Journal of the Society of Chemical Industry*, 1920.

A similar process is used by Messrs. Imperial Chemical Industries at Billingham. Here a dry mixture of 80 per cent. anhydride, 7 per cent. coke and 13 per cent. clay is crushed and passed through tube mills. From the tube mills the raw meals is taken to blending hoppers and then to a rotary kiln similar to the usual type of cement kiln. The kiln process results in the production of clinker and gases.

From the clinker cement is produced, and the gases are passed through an electric precipitation plant of Lodge-Cottroll type and then through scrubbing towers. From the scrubbing towers the gases pass on to a sulphuric acid contact plant where 100 per cent. strength sulphuric acid is produced. Two tons of raw meal produce one ton of clinker and one ton of 100 per cent. acid. The production of the plant at Billingham was, prior to the war, 60,000 tons of 100 per cent. acid annually.

It is clear, however, that sulphur production would be of greater industrial assistance to India than sulphuric acid manufacture. To utilise this process for the production of sulphur instead of sulphuric acid would entail that the kiln gases containing sulphur dioxide, instead of being treated in a chamber or contact plant to produce sulphuric acid, would be treated according to the pooled patents and developments which were being exploited by Lurgi Gasellschaft fur Chemie und Huttenwesen m.b.H and which are now presumably being worked by Messrs. Sulphur Patents Ltd., as described above.

The economics of the process depend greatly on the price obtained for the cement produced from the clinker and this aspect of the matter is of special importance in regard to India, as there is already a large well-established cement industry in the country with surplus manufacturing plant capacity. Schemes of this type based on the existing or suitably modified processes are being examined by the Associated Cement Company and the Mysore Cement Works. It must, however, be remembered that the cost of a pilot plant for this will be in the neighbourhood of Rs. 20 to 30 thousand and if these experiments prove successful as they no doubt will, the plant itself will cost anything from Rs. 20 to 30 lakhs subject to the patent position and a certain well-known firm would be willing to instal this equipment if the Government is willing to give certain guarantees regarding the purchase of the product now, as well as, after the war, and the matter is, I believe, engaging the attention of the Government.

The Orkla Process.—This process has been developed by Messrs. The Orkla Gurbeaktiebolag of Norway for the production of sulphur from pyrites. In 1927 a 40-ton plant was erected by the firm at their Lokken mine and subsequently in 1931 a much larger plant was erected at Thamshavn on the Orkdal Fjord, having an annual capacity of 200,000 tons of sulphur. The process has now been developed successfully to yield from 85 to 90 per cent. of the sulphur, and the copper in the ore can be obtained at an economical cost. The process consists in first smelting the pyrites in a blast furnace with quartz and limestone and slagging a large part of the iron content of the ore, the copper and other metals of value being collected in the first matte. It is understood that in this smelting operation an excess of coke and a minimum supply of ore are used. The furnace gases contain sulphur vapour, sulphur dioxide and carbon disulphide. With the aid of suitable catalysts (iron and aluminium oxides have been proposed) the constituents of the gas mixture at a temperature of 350/400° C. are caused to react. Carbon dioxide and elemental sulphur are formed, the latter being thereafter solidified by condensation.

Pyrites.—Several methods have been examined and developed for the manufacture of sulphur from pyrites. In the laboratories of the Director of Scientific and

Industrial Research at Calcutta, Mr. J. N. Sarkar has investigated the possibility of making sulphur by the interaction of sulphur dioxide obtained by burning the iron pyrites and sulphuretted hydrogen obtained by the action of lime, coal dust and steam on heated pyrites. Several catalysts have been tried and the process has yielded fairly satisfactory results and a pilot plant is under construction.

The Orkla process was developed particularly to utilise iron pyrites. Now that several new deposits of pyrites have been recently reported by the Geological Survey of India and the quantity available seems to be ample, the above processes have acquired special significance.

Pure pyrites contains 46·6 per cent. of iron and 53·4 per cent. of sulphur. It burns when heated in air or oxygen and produces sulphur dioxide. It is, however, more difficult to ignite pyrites than sulphur. Ores marketed for the manufacture of sulphuric acid usually contain from 42 to 47 per cent. of sulphur, but material containing as little as 30 per cent. of sulphur can be successfully burnt. On account of the cost of transporting and handling the large proportion of inert material in pyrites, however, the material used for acid making should be as high in sulphur as possible, as the value of the pyrites to the manufacturer of sulphuric acid depends almost entirely on the sulphur content and only to a small extent on the nature and amount of the impurities in the ore. It is also important that the pyrites used for this purpose shall be equally as free as sulphur from injurious components such as arsenic, chlorine, fluorine, antimony, selenium and telerium.

Because of its considerable content of inert material, pyrites cannot be readily substituted for raw sulphur and burnt in sulphur burners. Owing to the considerable production of cinder and burnt ore when using this material, pyrites burners require to be provided with special grates and facilities for removal of the clinker and burnt ore, and in this respect they differ materially from sulphur burners.

A notable step has been taken by Dr. Kedar Nath of Simla who has installed pyrites burners in his chemical works in Agra and the plant has yielded good sulphuric acid at competitive prices. To persuade existing sulphuric acid manufacturers in India to utilise pyrites, the price at which the pyrites can be offered to them should be such as to compare favourably with the price of raw sulphur, not only when allowing for the lower sulphur content but also for the capital expenditure necessary to substitute their existing sulphur burners with burners specially designed and made for the burning of pyrites. Owing to the paucity of sulphur, increasing amounts of pyrites both from Simla and the Sone Valley should be employed for manufacturing sulphuric acid.

Sulphuric Compounds from Coal and Oil.—Mr. N. L. Dutta has been associated with the Director, Scientific and Industrial Research, on investigations on the sulphur content of coals and oils. Investigations have been particularly carried out on "Wakting coal" and other coals of high sulphur content obtained from Dr. Fox of Geological Survey of India. The total sulphur of some of these coals have been found to be as high as 6·5 per cent. A substantial quantity of it is in the organic form so that it is possible to extract the sulphur compounds by solvent processes or steam distillation. The sulphur compounds as such or after chemical reaction produce materials which may be useful as anti-oxidants and as accelerators or retarders in vulcanizing processes. Preliminary work on these sulphur compounds has shown that extraction is pretty difficult but a number of important organic sulphur compounds have been extracted and their properties are being examined. This problem is of interest as these sulphur compounds are rather expensive and if they can be removed by a cheap process from the coal, the coal itself will become more useful and a good price could be fetched by developing the sulphur compounds.

Deposits of Sulphur and Sulphur-bearing Materials.—Perhaps the most important development in the sulphur position is the location of more than one sulphur mine in India. In literature the largest sulphur deposit in India is described as being located about 12 miles south-west of Sanni in the Kalat State, Baluchistan. Sulphur was at one time mined at the spot but these operations ceased some sixty years ago as a result of a fire. *The Records of the Geological Survey of India*, Vol. L, page 137 (1919) state that the deposit is estimated to amount to at least 36,000 tons of sulphur rock assaying approximately 28·8 per cent. of free

sulphur, which is equivalent to 10,000 tons of sulphur. The mine is 40 miles from Bellpat, the Railway Station. Sulphur also occurs in other parts of Baluchistan, *e.g.*, on the extinct volcano of the Koh-i-Sultan and other volcanic regions in the desert district of Chagai.

Recent work carried out by the Geological Survey under the auspices of the Board of Scientific and Industrial Research and the Sulphur Committee, has proved extremely fruitful and it is estimated that at one place in the surface deposits alone approximately thirty thousand tons of sulphur rock are available and mining operations will probably produce very much more. The deep boring operations in Baluchistan have been reported to be capable of yielding even larger quantities. Proposals are before the Government for working out the deposits in these two places and while the boring operations in the Sanni district have not yet been resorted to, there is no doubt that the success of the first deposit will lead to greater efforts on our part for obtaining more sulphur by boring. For obvious reasons it is not necessary nor desirable to give fuller details of the quantities of sulphur now required for India and the Eastern Group Nations in the British Empire, but it can be well imagined that the requirements will be large and for this reason, the report that the Simla mines of iron pyrites and the iron pyrites discovered in Sone Valley are not so small as they were at one time pictured, is of special interest. Iron pyrites have also been discovered in the Hyderabad State. The occurrence of sulphur and the large quantity of iron pyrites is a hopeful sign for the rapid development of sulphur sources in this country.

ANNALS OF BIOCHEMISTRY AND EXPERIMENTAL MEDICINE

THIS is a new addition to the specialist scientific journals in this country. The Journal "is meant to publish original papers. It also publishes reviews on scientific subjects and books and reports of scientific interest". The first number has sixteen contributions covering 116 pages.

In a foreword to the first number of the *Quarterly Review of Biology*, Raymond Pearl writes: "It is reported that there exist in the world to-day approximately 25,000 reputable scientific journals, devoted in whole or part to the publication of the results of research. In the face of such an overwhelming statistic it is entirely appropriate to raise the question: why start another? As the *Quarterly Review of Biology* stands, at the moment, in the position of the latest addition to the already large population of scientific journals, there is an obligation to make some statement as to its *raison d'etre*. This obligation may fairly be judged a moral one, because like all forms of population growth, that of scientific journalism shows definitely a tendency to approach a state of troublesome saturation." This statement was made fifteen years ago, in January 1926, and to-day it has greater significance.

In the light of the above, two questions may be asked: Was there a sound justification for a new journal? Could not have the existing journals satisfied the interests intended to be served by the new journal? These questions are important for a country whose budget for the advancement of science is miserably small.

The promoters of this new venture have, no doubt, considered these aspects and felt the need of a new journal in addition to those already existing. Let us hope that this feeling is shared by a large number of scientific workers in the country, whose sympathy and co-operation is essential in conducting and maintaining a high standard for the Journal.

We welcome the Journal and wish it a long and purposeful career.

LETTERS TO THE EDITOR

A SIGNIFICANT CASE OF MIRROR DRAWING

LEARNING a new type of eye-hand co-ordination has been the subject of elaborate experimental study, as well as of theoretical discussion. Dearborn,[1] Starch,[2] Hill,[3] and Snoddy[4] have drawn attention to the mirror drawing experiment as a striking example of learning by the method of trial and error. The impression has gained firm ground that in this experiment we have to look, apart from 'transfer', only for one factor, that is, the breaking up of an old co-ordination, and the establishment of a new one by trial and error. Whipple[5] commenting on this experiment, says, 'In the mirror-drawing test, the conditions preclude the use of imitation, and there is but relatively little opportunity to employ ideational control; whatever improvement appears is due primarily to a process of trial and error.' But, recently Ll. Wynn Jones[6] following the brilliant lead given by Gopalaswami[7] has shown the futility of the 'trial and error' attitude (inspired by mechanistic psychology) towards learning. "Until recently," says Prof. Jones, "it was customary to say that improvement in mirror drawing occurred through trial and error and that reasoning as such had little or no part. This attitude is characteristic of all 'mechanical' theories which involve the notion of random or 'chance' movements. Opposed to such views is the 'rational' theory of Professor Spearman. According to this theory 'rational' or 'intelligent' movement plays an important part in mirror drawing."

This is the first step in breaking off the shackles, imposed upon our thinking, by the mechanistic theories of learning. The next is to bring in *the conative factor* in learning. Stratton's famous experiment gave us the clue here. There the subject was very strongly motivated. He had perforce to achieve mentally the task of overcoming the effect of reversal. Could not the same effect be produced in the mirror drawing experiment? That was the problem which this variation of the usual experiment set out to solve.

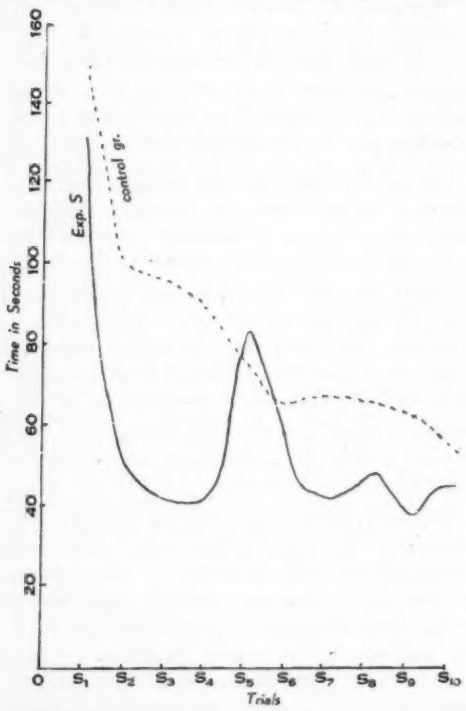
The usual outfit with the old type of the star-blank was used. The subject was an intelligent Honours Graduate of our School of Philosophy, who was familiar with details of the experiment. Ten trials were taken by the subject, in the mirror, with his skilled (right) hand. After S_1 a very strong incentive was given to make the subject highly motivated. He was told of the striking records in other laboratories, and when he was impressed, he was invited to beat those records

by devising some method of facilitating considerably his performance in the mirror. Suddenly, the possibility of a 'mental reversal' was hit upon, and the results are given below*:

Trial No.	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_9	S_{10}
Time in secs.	135	53	43	42·5	84	54	43·5	51	39·5	47

The average for a control group of three taking the test in the usual way without any suggestions from the experimenter is given below:

Trial No.	S_1	S_2	S_3	S_4	S_5	S_6	S_7	S_8	S_9	S_{10}
Time in secs.	148	100	97	90	75	67	69	68	65	57



* S, without mirror = 24 secs.
U, " " 31·5 "
U_1, with " 135 "

It is remarkable that even at the very first attempt (S_2) after the subject was strongly motivated, he was able to achieve a notable result in the shape of a reduction of 60·1 per cent. of the original time, while the control group produced only a reduction of 33·1 per cent. Moreover at no stage in the experiment did the control group achieve the result of the experimental subject in his first attempt after being strongly motivated.

Introspective results revealed that mental re-reversal was achieved, but the effort required was intense. There was a steady progress in the experiment as indicated by the graph up to the fifth trial, when suddenly the subject relaxed, and lost his 'mental picture'.

The result was a sudden shooting up of the time, and a consequent steep rise in the graph. E then kept on urging S to regain the picture.

There was success again, followed by another breakdown at the tenth attempt. The rise in time at the eighth attempt is due to external causes.

When the efficiency of the performance is considered, we get the same result. The third and the fourth arms of the star-blank have been chosen for reproduction in this note as the subject found them to be the most difficult. At S_5 many random and inefficient movements have been made, as well as at S_{10}.

So long as the subject was strongly motivated his performance was improving in time and efficiency. The sudden improvement at S_2 is noteworthy as due to the effect of a strong motive. It is clear then, that to speak of trial and error alone as the principle of explanation of learning in cases of this type is misleading. The conative factor must be taken into consideration. This experiment has opened up a new vista for the approach to the problem of learning which we expect to pursue in our further investigations.

P. S. Naidu.

Annamalai University,
Annamalainagar,
November 15, 1940.

[1] Dearborn, *J. of Ed. Ps.*, 1910, **1**, 373–388.

[2] Starch, *Ps. B.*, 1910, 20–23.

[3] Hill, *J. of Ed. Ps.*, 1914, **5**, 375–386.

[4] Snoddy, *Ps. Monog.* 1920, **28**.

[5] Whipple, *Manual of Mental and Physical Tests, Complex Processes* (Warwick & York, Baltimore), 1921, p. 119.

[6] Jones, *An Introduction to the Theory and Practice of Psychology* (Macmillan), 1934, p. 69.

[7] Gopalaswami, *Br. J. of Ps.*, 1923–24, **14**, 274.

NATURE OF RECEPTORS IN THE HUMAN RETINA

The normal photopic field of vision for a well-illuminated white object 10 mm. square at a distance of 45 cm. is a horizontally oval area extending upwards about 50°, outwards 90°, downwards 70°, and inwards 60°. It varies with intensity and quality of the stimulus, size of the test object and the state of adaptation of the eye. Field for colours are smaller by ordinary clinical methods those for blue and yellow pigmented objects are about 10° smaller than that for white and those for red and green 20° smaller, the green field being usually smaller than the red.

Ferree and Rand[1] have investigated the shape and size of fields for colour stimuli of equal energy. With stimuli of medium intensities of equal energy the limits of red and blue interlace. Those of green are narrower. Thus the green and red areas which are small in photopic field of vision extend to a greater limit.

Again when the eye is tested for fields of colour vision foveal region alone gives the unadultered photopic reactions unless the eye is very completely adapted to light so that all traces of scotopia are eliminated from the peripheral field. This point is often neglected by physiologists. As a result of which the foveal region and peripheral region do not give concordant results. The author by making the whole of the retina as far as possible photopic by exposure to sunlight for a long time (bearable by the author) and taking field of vision for colours (blue, red and green test objects 2 mm. diameter) has found out within the limits of experimental error blue zone, green zone and red zone are concentric in contradistinction to blue zone, red zone and green zone obtained with partially scotopic peripheral field.

Roaf[2] in his researches has found out that for central vision long wave-lengths raise the threshold for all regions of the spectrum and blue mechanism is stimulated by the whole spectrum,[3] whereas short wave-length of the spectrum stimulates only one set, i.e., blue mechanism only.

For peripheral vision short wave-lengths raise the threshold for the whole spectrum. In his experiments the scotopic peripheral field was not made photopic and so he has obtained different results for peripheral vision. The author by eliminating all traces of scotopia from the peripheral field has secured the same

type of results as was obtained for foveal vision. This clearly points out that attention to photopic nature of peripheral field is important in all experiments conducted on colour vision in the periphery of the retina.

A. S. RAMASWAMY.

University Medical College,
Mysore,
April 5, 1941.

[1] Ferree and Rand, *Psychol. Rev.*, 1919, **26**, 150; 1920, **27**, 1; *Trans. Amer. Ophth. Soc.*, 1920, **18**, 244; *Amer. Jl. of Ophth.*, 1920, **3**, 772.

[2] Roaf, *Nature*, 1930, **126**, 825.

[3] Roaf, *Jour. Physiol.*, 69; *Proc.*, 1929, p. 1.

ROOT-ROT OF SUGARCANE

DURING August 1939 a portion of a sugarcane field planted to Co. 413 in the vicinity of the Agricultural Research Institute was infected by a root-rot disease. The crop was 3 months old and some of the plants were in a poor unthrifty condition with many of the leaves drying up in spite of the fact that there was sufficient water. When the diseased plants were dug up it was observed that the roots were few and diseased. The older roots were dead and dark brown in colour. The new roots showed red discolouration in several places along the length. In a few plants the base of the stem of shoots had rotted.

Sections of the diseased roots in various stages of infection showed the presence of hyaline non-septate hyphæ in the cortex. Oospores were also present in some sections. Bits of roots in the early stages of infection were washed in ·1 per cent. mercuric chloride solution for two minutes and then in sterilised water and placed in Petri-dishes containing quaker-oats agar. In three days white growths of a *Pythium* developed from most of the bits. From these the fungus was brought into pure culture.

On quaker-oats and french bean agars the fungus produces a luxuriant felt-like growth. Oospores are formed in plenty in a week. These are spherical, smooth and filling up most of the oogonial cavity. They measure 22·5μ (the range being 18·9–25·2μ) (Fig. 5). The oogonia measure 26·7μ in diameter (range, 21·0–29·4μ). One to four antheridia have been found attached to a single oogonium. Sporangia are spherical or oval (Fig. 1) and form terminally at the ends of long stalks. These are not common on solid media but when bits of culture are floated in distilled water they develop in plenty

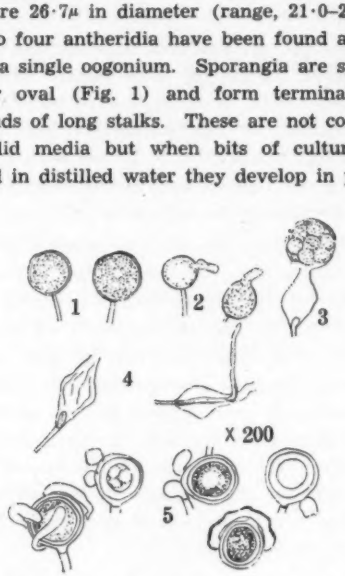


Fig. 1—Sporangia; Figs. 2-3—Germination of sporangia; Fig. 4—Proliferation; Fig. 5—Oospores.

in 24 hours. Small tubular outgrowths are produced by the sporangia and these form vesicles into which the protoplasm flows. Differentiation into zoospores takes place and the vesicle bursts liberating the zoospores 16–20 in number (Figs. 2–3). After the discharge of zoospores and in some cases just at that time, a hypha begins to grow through the sporangium starting from the point of attachment of the stalk to the sporangium. This hypha grows out and sometimes branches and continues the mycelial growth. This resembles one of the methods of proliferation observed by Butler[1] in *Pythium*. But sporangial formation at the tip of the proliferated hypha has not been observed. This isolate resembles *P. deBaryanum* excepting for bigger size of the oogonium and oospore. *P. deBaryanum* has been recorded as one of the species causing root-rot of sugarcane in Louisiana.[2]

Inoculations were made by placing cultures

of the fungus in the root region of sprouting setts of Co. 413 in pots. After 15 days the roots were found to be reddened and rotten and the fungus was reisolated from the diseased roots. Some plants were allowed to remain in the pots for two months. But they did not make good growth as compared with the controls. It was found that the root system in the inoculated plants was poor and consisted of a high percentage of dead and diseased roots. Thus the pathogenicity of this isolate on sugarcane roots was established.

Le Beau[3] has noticed in his experiments that applications of nitrates increased root-rot by *Pythium* in sugarcane. In Coimbatore the root-rot trouble commenced after the application of ammonium sulphate to the fields and it was more evident in the areas at a lower level. The fields were then flooded and drained alternately with water for a week with the idea of removing the excess of salts. The progress of the disease was arrested and there was no fresh infection after a week. This confirms Le Beau's observations on the relation between nitrate application and root-rot caused by *Pythium*.

T. S. RAMAKRISHNAN.
Agricultural Research Institute,
Coimbatore,
March 29, 1941.

[1] Butler, E. J., *Mem. Dept. Ag. Ind. Bot. Series*, 1907, **1**.
[2] Rands, R. D., and Dopp, E., *U. S. Dept. Ag. Tech. Bull.*, 1938, 666.
[3] Le Beau, F. J., *Rev. App. Myc.*, 1939, **18**, 618.

ALBINISM IN *LABLAB*

THE occurrence of a chlorina type of chlorophyll deficiency which has little or no lethal effect has been reported in the garden variety of lablab (*Dolichos lablab* L.).[1] The chlorina type is produced by a factor c_a while its allelomorph C_a is necessary for the normal green.

The occurrence and inheritance of an albina type in the field variety of lablab (*Dolichos lablab* Roxb.) is reported herein. Like the chlorina type, the albina type is met with in many species of plants.[2] It is more common in cereals than in pulses. The albina seedlings in lablab were observed in the F_2 generation of a cross for the pursuit of inheritance of testa colour pattern. The parents and the F_1 were normal green while the F_2 gave 156 normal green and 44 albina (Fig.). The albina

Normal green and albina seedlings

plants died when about 12 days old. From the normal green plants 20 selections were carried forward to the next generation. Eight of these bred true for normal green while twelve segregated, giving a total of 663 normal green and 210 albina plants. This experience is the first record of a monogenic segregation for albinism in the pulse *Dolichos lablab* Roxb.

G. N. RANGASWAMI AYYANGAR.
K. KUNHI KRISHNAN NAMBIAR.
Millets Breeding Station,
Coimbatore,
April 19, 1941.

[1] *Proc. Ind. Acad. Sci.* (B), 1935, **1**, 857.
[2] *Bibliogr. Genet.*, 1933, **10**, 357.

TRICOTYLEDONY IN *LABLAB*

THE occurrence of tricotyledonous seedlings is a fairly common phenomenon in the dicots. According to Buchholz[1] who examined the embryos of pine, spruce, larch, juniper, etc.,

the polycotyledonous condition is primitive and the dicotyledonous one derived. On the basis of this theory, Gager[2] concludes that the rather common abnormal appearance of supernumerary cotyledons in the dicots is a reversion to a more primitive condition. De Vries[3] calculated the heredity percentage of tricotyls in several species of plants and observed that this percentage is higher in the cultivated plants.

At the Millets Breeding Station, Coimbatore, a tricotyledonous seedling was observed in the garden variety of lablab (*Dolichos lablab*, L.). The seedling had three distinct cotyledons, of which one was more or less normal in size, the other two being smaller. The first foliar leaves in this seedling were as usual simple, but were three in number instead of the normal two. This tricotyledonous seedling was grown to the adult stage and out of 449 of its seeds examined (from 100 pods) 10 were found to be tricotyledonous as well as having three simple first foliar leaves.

G. N. Rangaswami Ayyangar.
K. Kunhi Krishnan Nambiar.
Millets Breeding Station,
Coimbatore,
April 19, 1941.

[1] *Amer. Jour. Bot.*, 1919, **6**, 106.

[2] Gager, C. S., *Heredity and Evolution in Plants*, 1920.

[3] Vries, Hugo de, *Species and Varieties: Their Origin by Mutation*, 1906.

A NEW TYPE OF MECHANICAL CONSTRUCTION IN THE STEM OF *PANICUM PUNCTATUM* BURM.

Monocotyledons are particularly characterised by an extraordinary degree of variation in the types of mechanical construction of their inflexible organs. Schwendener[2] noted 28 types of such construction in this class alone, and arranged them into a number of mechanical systems. But the type under discussion has not been reported, so far as the writer can find out, by Van Tieghem, Schwendener or Haberlandt.[1] As a detailed report on the anatomy of this plant will form the subject-matter of another paper, only the mechanical construction of the adult stem is described here.

The epidermis and one or two hypodermal layers have their walls thickened and lignified to form the hard rind characteristic of the Grass family. The subhypodermal ground tissue is characterised by the presence of a ring of air cavities which run in longitudinal rows through the internode. The vascular bundles are arranged in radial rows at regular intervals occupying the regions between successive air cavities, the largest bundles being always towards the centre of the stem. The stereome runs in the form of an inverted arch encircling more than half of each air cavity on the inner and lateral sides and joining firmly to the top of the vertical pillars built up of the composite girders formed by the bundles in each radial row. The centre of the stem is occupied by a big cavity formed by the disorganisation of the pith cells (Fig. 1).

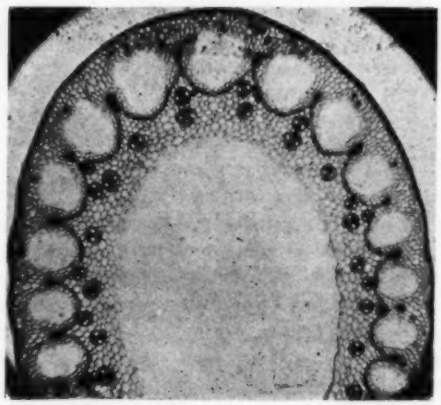


Fig. 1

T. S. of adult stem

The plant grows in water and mud, and is subjected to lateral compression and bending. In this case the mechanical construction, it appears, has been followed on the principle of the construction of a suspension bridge instead of that of an I-girder. A suspension bridge

"consists of two or more chains constructed of links connected by pins or of twisted wire strands, or of wires laid parallel. The chains pass over lofty piers on which they usually rest on saddles carried by rollers and are laid down on either side to anchorages in rock chambers". Thus in a suspension bridge *three* things are necessary, *viz.*, *lofty towers* over which the *wire ropes* of very great tenacity passes, and the *massive anchorage*. The lofty towers in this case are the vertical pillars constructed on the girder principle, the wire ropes are the continuous inverted arches of stereome, and the anchorage instead of being local and massive is more efficient and economical in the fact that the stereome is continuous round the stem in the form of a wavy ring passing at definite intervals over vertical towers. When compressed due to a temporary load (stress) any deflection is resisted by the stereome tissue as a whole.

What is considered a defect in a suspension bridge, i.e., its flexibility, is in fact a necessity in the stem of these plants. As regards the material of the wire ropes iron and steel of strongest form is used, and the tensile strength of sclerenchyma cells, of which the stereome is constructed, is equal to that of wrought iron (15–20 kilograms per sq. mm.), and in some cases "vies even with steel in this respect". Its strength increases with diminishing water contents, while its elasticity is correspondingly diminished making the older parts of the stem more rigid than the younger ones.

GIRIJA P. MAJUMDAR.

Department of Botany,
Presidency College, Calcutta,
April 1941.

[1] G. Haberlandt, *Physiological Plant Anatomy*, Eng. Ed., 1914.

[2] S. Schwendener, *Das Mechanische Princip im Anatomischen bau der Monocotylen*, 1874.

THE DEVELOPMENT OF ENDOSPERM IN *LEUCAS ASPERA* SPRENG.

SCHNARF[1] (1931) has summarised the literature on the embryology of the Labiatæ. The more recent investigations on endosperm development in the family include those of Ruttle[2] (1931) on *Mentha*, Carlson and Stuart[3] (1936) on species of *Salvia*, and Junell[4] (1937), who has investigated a large number of representatives of the family. But the investigations are mainly confined to European and American species and the information regarding the species indigenous to India has been very meagre. The author[5] (1940) has published an account of the development of the embryo-sac and endosperm in three species of *Ocimum*. The present study is a short account of the development of endosperm in *Leucas aspera*. The detailed paper on the embryology of this species will be published elsewhere.

Soon after fertilisation, the secondary nucleus migrates to the narrow chalazal region of the

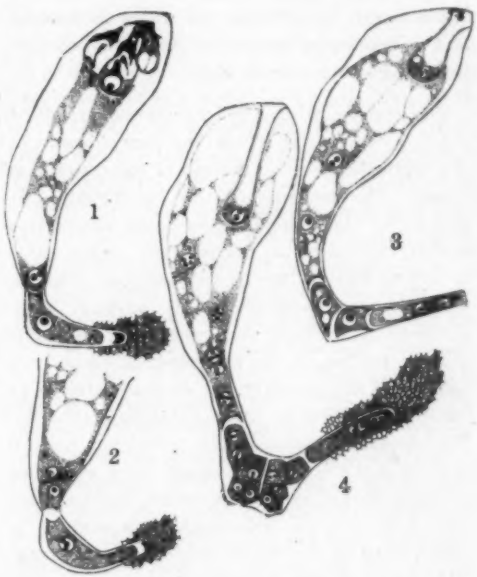


Fig. 1—First division of the primray endosperm nucleus. × 800. Fig. 2—Chalazal portion of the embryo-sac showing the chalazal haustorial cell, middle cell, and micropylar chamber containing the nucleus. × 800. Fig. 3—Embryo-sac showing the chalazal haustorium, endosperm cells, two-nucleate micropylar haustorium and the fertilized egg × 800. Fig. 4—Embryo-sac showing the chalazal haustorium entering the vascular bundle, the endosperm tissue, 4-nucleate micropylar haustorium and the elongated fertilised egg. × 800.

embryo-sac, where it divides followed by a transverse wall (Fig. 1). Of the resulting two cells, the nucleus of the chalazal cell divides once without any wall formation. The resulting two nuclei organise a chalazal haustorium which penetrates the vascular trace. The upper of the two cells divides transversely, separating a middle cell and a large micropylar chamber (Fig. 2). The middle cell, by transverse and vertical divisions, gives rise to the endosperm tissue (Figs. 3 and 4). The nucleus in the micropylar chamber of the embryo-sac divides in a free nuclear manner and gives rise to a number of nuclei which organise a micropylar haustorium (Figs. 4 and 5). The embryo-sac is thus divided into 3 portions, *viz.*, a chalazal haustorium, cellular endosperm region and a large micropylar haustorium. The fertilised egg elongates into a long suspensor without any cell division and becomes encased in the developing endosperm tissue, where further development takes place.

The activity of the chalazal haustorium is of short duration, and it can be observed only at the early stages of the growth of the endosperm tissue. The contents of this haustorium disappear by the time the micropylar haustorium is fully organised so that a mere empty canal is left to denote its original position (Fig. 5). The micropylar haustorium, on the other hand, develops aggressively and extensively absorbing a large portion of the integumental tissue. At the height of its activity it shows twelve large nuclei embedded in dense cytoplasm (Fig. 5). The connection between the micropylar haustorium and the endosperm tissue is by a narrow isthmus formation through which the nutrition absorbed by the micropylar haustorium is transported to the developing endosperm tissue. The nuclei of the micropylar haustorium contain two to three nucleoli. Later stages of the haustorium are characterised by the disintegrating cytoplasm containing amœboid nuclei (Fig. 6).

The development of the endosperm tissue, in the early stages, extends towards the chalazal part of the ovule where a large amount of the chalazal tissue is absorbed. At this period the micropylar haustorium is very active digesting the micropylar tissues. The further development of the endosperm extends towards the micropylar part of the ovule

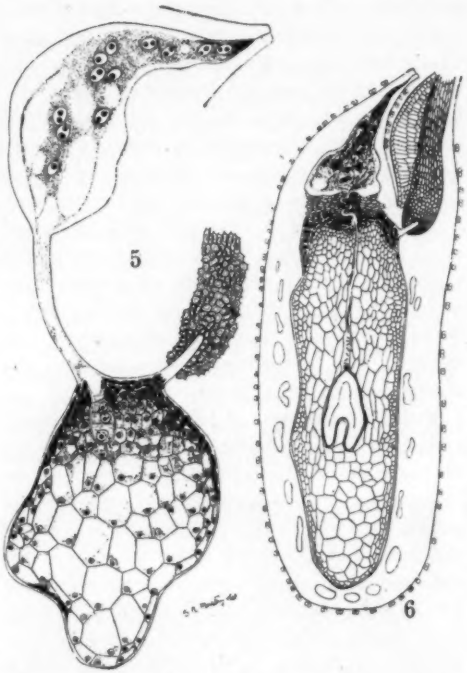


Fig. 5—12-Nucleate micropylar haustorium, the proembryo embedded in the endosperm tissue and an empty canal representing the chalazal haustorium. × 560.
Fig. 6—Section of ovule showing the embryo in the centre of the endosperm tissue, the disintegrating micropylar haustorium with amœboid nuclei, and the glandular hairs. × 240.

gradually obliterating the micropylar haustorium. The isthmus which connects the micropylar haustorium with the endosperm tissue becomes twisted and crushed (Fig. 6). The micropylar haustorium itself soon becomes empty giving place to the advancing endosperm tissue which, later, occupies most of the ovule. The peripheral cells of the endosperm tissue transform themselves into highly chromatic conducting cells, and the cells towards the centre are larger and less chromatic.

The embryo develops in the middle of the endosperm tissue (Fig. 6) and finally displaces it.

The formation of two-celled glandular hairs on the ovule after fertilisation has been noticed in this species. These glandular hairs persist for a long time during endosperm development.

In conclusion, the author wishes to record his sincere thanks to Dr. M. A. Sampathkumaran, Professor of Botany, for his kind criticisms.

S. Narasimha Murthy.

Department of Botany,
Central College, Bangalore,
April 5, 1941.

[1] Schnarf, K., *Vergleichende Embryologie der Angiospermen*, Berlin, 1931.

[2] Ruttle, M., "Cytological and Embryological Studie on the Genus *Mentha*," *Gartenbauwiss*, 1931, **4**, 428.

[3] Carlson, E. M., and Stuart, B. C., *New Phytologist*, 1936, **35**, No. 1, 68.

[4] Junell, S., *Sartryck ur Svensk Botanisk Tidskrift*, 1937, Bd. 31, Hft. I.

[5] Narasimha Murthy, S., "Studies in the Labiatæ, I" *Journal of the Mysore University*, 1940, **1**, Part 10, 97.

ON TWO KINDS OF FISH EGGS HATCHED OUT IN THE LABORATORY OF WEST HILL BIOLOGICAL STATION, CALICUT*

The occurrence of two types of fish eggs, namely, those of *Anodontostoma chacunda** and of *Caranx crumenopthalmus* in the plankton obtained from a depth of 4 fathoms at a distance of 2 miles from the shore, opposite the Marine Biological Station, in January 1940, aroused fresh interest in the study of fish eggs which is one of the routine items of work in the Biological Station. Both fishes are economically important. The horse mackerel is more abundant than the other in the West Coast and on an average about 55,000 maunds of fish valued at Rs. 52,000 are landed every year. In the year 1938–39 this fishery yielded a maximum of 229,257 maunds valued at Rs. 1,70,416.

* Published with the permission of the Director of Industries and Commerce, Madras.

I. Anodontostoma chacunda

Five batches of eggs of this fish came under observation in January 1940 on the 15th, 16th, 17th, 24th and 29th respectively. They were isolated from the inshore plankton off West Hill. As this fish was practically absent in the catches made by the fishermen in January, one is led to conclude that they were spawning off shore beyond the reach of the fishermen. By special efforts, two specimens of this fish were obtained through the assistance of the hook and line fishermen† from the off shore 10 miles away. Both happened to be females with ripe ovaries. The ova were transparent. Needless to say, artificial fertilization could not be tried in the circumstances.

8 A.M. The eggs were identified as those of *Anodontostoma chacunda* with the help of Delsman's description.[2] The eggs found in the morning plankton were fairly advanced in development, suggesting that they might have been laid the previous night, as is well known in the case of most of the fishes in tropical waters. The eggs are of a slightly yellow colour but the oil-globules are colourless. The embryo is formed showing the head-fold and the tail-fold. The diameter of the entire egg is about 0·82 mm. The number of oil globules is 6.

9 A.M. After the lapse of one hour, the egg swells a little, evidently through the absorption of water, for its diameter has now increased to 1·05 mm. The number of oil-globules is 12. It could not be ascertained if this increase in number was due to a division of the original oil-globules or to the addition of oil-globules which rose *de novo*. The head of the embryo is differentiated; optic vesicles are formed and the tail becomes a little curved at the other end, thus showing the progress in the growth made by the embryo. The chromatophores make their appearance in the middle portion of the embryo.

11 A.M. At the end of 3 hours the curved embryo has embraced the yolk completely, the diameter of the egg being 1·14 mm. and there are 20 oil-globules. These are no longer distributed over the yolk mass but are crowded

together at the region corresponding to the middle of the future larva and the posterior portion of its yolk-sac.

About 1 P.M. the larvæ generally hatch out. Their average length is 2·66 mm. The eyes are well developed. The auditory vesicles are formed. The contraction of the heart is evident. The oil-globules are collected at the posterior region of the yolk-sac. The anus is at a distance 1·88 mm. from the tip of the head. There are 35 myotomes in front of the anus and 12 behind it. The chromatophores make their appearance along the dorsal region of myotomes and are also found in the head region above the auditory vesicle.

In twenty-six hours, the larva has grown to a length of about 4·28 mm.

The larvæ that hatched out on 29–1–1940 lived for 36 hours. Their length was 4·35 mm. The heart was slightly bent in the shape of 'S' and its contractions can be seen clearly. The eyes have become deeply pigmented. The yolk has been completely absorbed. The pectoral fins make their first appearance as lobes. There are now 25 myotomes in front of and 22 behind the anus. According to Delsman there are 41 myotomes in the larva corresponding to the 41 vertebræ in the adult. But the larvæ in question had 47 myotomes. Further investigation appears to be necessary to reconcile this difference.

The phenomenon of the forward movement of the anus and the consequent reduction in the length of the trunk and increase in the length of the tail well known in the development of certain fishes is also seen here.

There are not many differences between the eggs described by Delsman and the eggs described by us. The fish according to the observation of Delsman spawned in the sea off Batavia in March where the water had a salinity of $29^0/_{00}$. He had also collected the fish eggs near Labuan, in September, where the salinity was $33^0/_{00}$. The salinity of the water off West Hill where we got these fish eggs was about $33^0/_{00}$. The fact that these fish eggs were also found in the plankton off West Hill from November 1939 till the end of February 1940 suggests that the spawning season of this fish extended from November to February during the period under our observation.

II. Caranx crumenopthalmus

In Indian waters no less than 26 species of caranx occur according to Day and the task therefore of referring the carangoid eggs found in plankton to the particular species will be a laborious one. According to Delsman[3] the eggs of the genus caranx are characterised by (*a*) the frothy nature of the yolk mass in the egg and by (*b*) the presence of a single large oil-globule in the anterior part of the yolk-sac in the newly hatched larva.

In the plankton collected in the sea off West Hill, eggs of the description given by Delsman are of common occurrence. In January of 1940, a carangoid egg happened to be abundant which event facilitated hatching. Three batches of eggs were hatched on 15–1–1940, 24–1–1940 and 29–1–1940 respectively. The colour of the egg was light yellow; the diameter of the egg was about 0·78 mm.; and the single large oil-globule measured about 0·24 mm. which is nearly a third of the diameter of the egg. The yolk mass was vacuolated. It should be stated that these eggs when isolated at 9 o'clock in the mornings, were in a state of advanced development. The embryo has been differentiated, the head and tail being prominent. This naturally leads one to believe that they must have been laid during the previous night. The oil-globule showed brownish red pigment-spots. This character distinguishes the eggs of carangoids from those of clupeoids which is the only other group of fishes that possesses eggs having vacuolated yolk.

Most of the eggs isolated in the laboratory hatched out at about 1–30 P.M. The length of the newly hatched larva is 1·35 mm. The oil-globule is in the anterior portion of the yolk-sac. The length of the tail is 0·75 mm. and the diameter of the oil-globule 0·15 mm. There are 7 myotomes in front of and 17 behind the anus. As regards the number of

myotomes, Delsman (3, p. 209) observed as follows:—

"For the number of trunk myotomes I found as a rule 12 sometimes 11 or 13, for those of the tail some 14, although in quite young larvæ, newly hatched, this number might amount to 16 or 17, besides the unsegmented part of the mesoderm corresponding to the urostyle. From this it is evident that the number of trunk myotomes as well as that of the tail myotomes decreases slightly during development. As stated above, the number of vertebræ in both species is 10 *plus* 14 (the urostyle included)."

Our observation does not support Delsman in this respect. The total number of myotomes was 24 in the larva corresponding to the 24 vertebræ of the adult carangoid.

These larvæ as soon as they hatch out were found swimming at the bottom of the vessel and not coming up to the surface. This perhaps indicates that in the sea the larvæ as soon as they hatch out descend down seeking the lower strata of the sea. The length of the larva, 20 hours after hatching is 1·95 mm. and the diameter of the oil-globule 0·1 mm.; the latter shows a reduction in size due to the oil being used up. There are 7 myotomes in front of and 17 behind the anus. A larger portion of the yolk-sac is absorbed. There are three distinct patches of chromatophores along the ventral side of the myotomes posterior to the anus. The head is slightly opaque. Two dark patches of melanophores are found in the anterior portion of the head.

In the next stage examined, *i.e.*, 44 hours after hatching, the length of the larva is 2·4 mm. There are 10 myotomes in front of and 14 behind the anus. The anus has shifted backward a process just the opposite to what was observed in the case of the larva of *Anodontostoma chacunda*. The eyes have almost turned black with a silvery eyelid. Chromatophores make their appearance along the dorsal portion of the myotomes in three patches. When the larva is 64 hours old, the yolk is completely absorbed. The eyes have become very dark and the auditory vesicles are well developed.

Delsman[3] has found the eggs of *Caranx crumenopthalmus* in plankton collected in May and June in the Java Sea. This perhaps indicates that this horse-mackerel has a different spawning season in the Arabian Sea. It is also interesting to note that generally this horse-mackerel locally called "Chamban" in Malabar is very rarely caught by the fishermen during the months of January and February. This fish is landed in plenty from July to November.

In the case of eggs of both the fishes described above, it is highly interesting to note that they are fairly common in the plankton during the months when the parent fishes are rarely caught. The inference, therefore, that during the spawning season these fishes seek breeding grounds far away from the shore beyond the fishing zone of the fishermen does not seem to be unreasonable.

D. W. Devanesan.
K. Chidambaram.

West-Hill Biological Station,
Calicut,
May 17, 1941.

* We have adopted this name from C. Tate Regan (5). Day's name for this fish is *Chatoessus chacunda*.

† These fishermen go beyond the zone usually fished by net fishermen.

[1] Day, F., *Fauna of British India · Fishes*, **1 & 2.**

[2] Delsman, H. C., *Fish-eggs and Larvæ from the Java Sea*, 1926, No. 8, p. 389.

[3] —, *Ibid.*, No. 5, p. 199.

[4] —, *Ibid.*, Nos. 6, 7.

[5] Regan, C. T., *Ann. Mag. Nat. Hist., Eighth Series*, **19,** No. 112, p. 316.

MICRO-ESTIMATION OF NITROGEN BY OXIDATIVE DIGESTION

Oxidative digestion[1] has been successfully applied to the rapid micro-estimation of total nitrogen in biological materials. The procedure is simple and rapid and may be outlined as follows:—

An aqueous solution or suspension (1 ml.) of the material is pipetted into a micro-Kjeldahl flask and treated with 2 ml. of

concentrated sulphuric acid (nitrogen-free, if available) and a small pinch (*Ca* 50 mg.) of mercuric oxide (this is to prevent possible interference from halides). The suspension is raised to boil, and, while it is boiling, an aqueous solution of chromic acid (100 per cent.; 0·2 to 0·3 ml.) is added drop by drop until a red brown colour is definitely established. (If the material is rich in organic matter, a larger quantity of chromic acid may be needed.) The boiling is continued with a moderately low flame for 5 minutes after which the digest is cooled and diluted with 5 to 10 ml. of ammonia-free water. Sodium sulphite (or bisulphite) (A.R.) is then added until the red brown colour is completely discharged and a pale green or bluish grey colour is developed. (Smell of sulphur dioxide will also be quite pronounced at this stage.) A small pinch (*Ca* 10–20 mg.) of pure zinc powder or dust is then added and the suspension boiled over a low flame for about 10 minutes. It is then cooled and distilled with excess of alkali from a micro-distillation apparatus in the usual way.

If the nitrogen content of the material is small, a larger volume of the aqueous solution or suspension may be taken, and, after addition of a drop of concentrated acid, the volume is reduced, by boiling, to under 1 ml. before introducing sulphuric acid.

The above operations can all be conducted at the work-bench in the laboratory. If the details are carefully followed and the height of the flames suitably adjusted, no acid fumes (or other offensive smell) are given out. A micro-Kjeldahl flask is convenient for the digestion, but in its absence, even an ordinary boiling tube (made of Pyrex or other resistant glass) may be used.

An important condition for success is that, at no time, after the commencement of heating and till the completion of digestion, should the temperature be allowed to drop below 130° C. Otherwise, there will be loss of nitrogen in elementary form (through decomposition of ammonium dichromate) with the result that fictitiously low estimates will be obtained. A safe procedure will be to keep the mixture constantly on the boil and to see that there is no slackening until the five-minute period is over. For the same reason, a cooled digest should not be re-heated until after reduction with the sulphite.

The titrations are carried out from the micro-burette. The Conway burette is more accurate, but requires careful manipulation. The titration method is not, however, quite reliable when the total nitrogen content is less than 10 μg. In such cases, independent checks by the colorimetric method against standard ammonium chloride (1 μg. of nitrogen per ml.) should be carried out.

The above procedure has been repeatedly compared with the ordinary method of Kjeldahl digestion using selenium as catalyst, and allowing for slight difference in blanks, identical results have been obtained in both the cases.

The method of oxidative digestion has been successfully applied in enzyme fractionation studies and has been of much value in rapidly assessing the degree of purity at each stage.

C. N. Bhima Rao.
M. V. Lakshminarayan Rao.
M. S. Ramaswamy.

Department of Biochemistry,
Indian Institute of Science,
Bangalore,
March 1941.

[1] Subrahmanyan, Narayanayya and Bhagvat, *Proc. Ind. Acad. Sci.*, **1934**, **1B**, 155; Narayanayya and Subrahmanyan, *Ibid.*, **1935**, **2B**, 213; Harihara Iyer and Rajagopalan, *J.S.C.I.* **1935**, **54**, 341T; Acharya, *Nature*, **1935**, **136**, 644; Bhaskaran, Harihara Iyer, Rajagopalan and Subrahmanyan, *I. Ind. Inst. Sci.*, **1936**, **19A**, 45.

REVIEWS

Cotton. By H. B. Brown. Second edition. (McGraw-Hill Publishing Co., Ltd.), 1938. Pp. 592. Price 30*sh.*

The appearance of a good book on cotton is a matter of special interest to Indian research workers on this important commodity. As proved by scientific and incontrovertible evidence, India was the first country to grow cotton on a fairly large scale and to use it for the manufacture of materials. During the middle ages the fame of its fabrics, its muslins and nainsooks, spread far and wide, indicating the presence of suitable raw material and a high degree of technical skill in the arts of spinning, weaving, dyeing, printing, etc. To-day, India produces the second largest crop in the world; and though the average quality of its cottons is not so high as that of the Egyptian or the American cottons, strenuous efforts are being made to grow better and still better types, and already a notable measure of success has been achieved in this direction. For all these reasons, we scanned with interest the pages of the second edition of Dr. H. B. Brown's book entitled *Cotton* and found, with a sense of pleasurable relief, that our labours were not wasted in any way.

Brown's book first made its appearance in 1926 and the present edition has been necessitated by the manifold advances made in the recent years in the domains of cotton breeding, study and control of cotton pests and diseases, and marketing and manufacture of cotton. The scope of the book is indicated by its sub-titles, which are as follows: History, Species, Varieties, Morphology, Breeding, Culture, Diseases, Marketing, and Uses. These sub-titles would give the reader a fair idea of the wide ground attempted to be covered by the book, which is profusely illustrated by graphs and diagrams and supplemented by tables containing useful data. Each chapter is followed by bibliographic references, for those who wish to pursue the subject further, to books and journals in which the subject-matter has been discussed at greater length.

Though the title of the book is perfectly general and a few references are to be found, scattered here and there, to non-American, especially the Egyptian varieties, the book deals mostly with the American cottons. Treatment on these lines may ensure continuity and impart an air of intensity; but, on the other hand, it is bound to narrow down the usefulness of the book, especially to non-American readers, by omitting to take into account the work that is being attempted in other countries. Thus, to take a few examples relating to Indian cottons only, no mention is made of the work done in Bombay Province on wilt resistance, in Madras on pampheres, in the Punjab on the development of Punjab–American types or at the Technological Laboratory on the relationships between the fibre-properties and the spinning quality of cottons. This paucity of treatment of non-American cottons cannot be entirely due to want of space, because certain portions of the book, *e.g.*, the history of Ely Whitney's litigations, are in our opinion unnecessarily discursive, and could well have been abridged without detracting from its value. Furthermore, the book contains, now and then, statements which seem to be the legacy of the past and remind one of the views sometimes expressed by old-fashioned practical carders and spinners. Thus, it is stated that "if their (fibres') diameter and twist or convolutions are uniform, they will fit together closely, thus making a strong thread". Actually, as anyone who has spent some time with a microscope on cotton fibres knows, uniformity of diameter or convolutions may be dreamt of as praiseworthy ideals, but are never achieved in practice.

In spite of these few drawbacks, to which we thought it our duty to draw attention, the book is a mine of useful information on most aspects of cotton, especially the American cottons, and the author has done well to bring out an up-to-date edition. There are certain chapters, such as those on economics of cotton production and cotton marketing, which should be carefully and widely read in India, where we have to learn a great deal from the experience gained in America. We can, therefore, confidently recommend this book, and hope that the new edition, like its predecessor, will find a place on the shelves of all those interested in cotton.

NAZIR AHMAD.

Corrosion of Iron and Steel. By J. C. Hudson. (Chapman & Hall, Ltd., London), 1940. Pp. 319. Price 18*sh.*

The annual loss to the world as a result of the wastage caused by the corrosion of

iron and steel is computed at more than several million pounds sterling. Although the evils of corrosion are commonly understood and have been known for ages, the problem of finding its causes, and steps to prevent deterioration of the metal due to corrosion is so complicated that until recently no scientific attempt was made for tackling it. About two decades ago, a Joint Committee was set up on behalf of the British Iron and Steel Institute and the Iron and Steel Federation to investigate this question. This Committee, consisting of eminent members of various Research Associations and practical steel makers and users, has, up till now, produced five valuable reports, which contain numerous experimental data collected from various service stations in different parts of the world, working under the control of the Committee.

The mass of information contained in these reports is so voluminous and of such detailed nature that it was felt that practical steel users, interested in corrosion, would have no time to go through these. The Committee, therefore, authorised one of its members, Mr. J. C. Hudson to publish a brief book on "the corrosion of iron and steel" giving a brief account of the reasons for corrosion, qualities of steel and iron that get most easily corroded, the agents of corrosion and finally the remedies to be adopted for minimising the effects of corrosion.

The earlier chapters of the book deal with the oxidation of iron and steel at elevated temperatures, the significance of rolling mill scale on the rusting process, and other corroding agents of iron and steel, *viz.*, atmosphere, sea-water, etc. Detailed account of the rusting of iron and steel in atmosphere and the practical suggestions given for prevention of this evil are full of interest. Use of low alloy steels containing small percentages of copper and chromium for steel structures, and various kinds of protective coatings for iron and steel are practical suggestions which should prove of considerable interest to designers of steel structures. As a result of elaborate investigations conducted by one of the Sub-Committees, detailed instructions have been suggested to the practical user of steel regarding the nature of paints to be used, the preparation before painting of the various steels to be protected, nature of inhibitive priming coats and finishing paints, as also compositions of suitable priming and finishing paints.

It may be of interest to users of steel in this country that the premier steel producing company in India, *viz.*, The Tata Iron and Steel Company, have, during the last few years, put on the market a special non-corroding steel, called by name, 'Tiscor' used for various steel structures.

The remedies for prevention of corrosion against chemical attacks—a problem of great importance to chemical industries—are briefly referred to. Extensive types of steels which are generally recommended for this purpose, *viz.*, stainless steels, containing large percentages of chromium or chromium and nickel have been dealt with. A comparison is made of these special types of steel with the mild steel as also of ferrous and non-ferrous metals. The variations in the rate of rusting are noted.

The last few paragraphs give a clear description of the importance of fundamental research and laboratory work. The actual work conducted at the various research institutions and universities and the uses to which these results have been put to are all described in detail. An account of the field tests conducted in various countries—United States of America, Belgium, France, Germany, etc.—is also referred to. Further, a survey is given of the present state of knowledge of soil corrosion, as also of the atmospheric corrosion of wires and the corrosion of steel sleepers.

The concluding part of the book touches on what remains to be done for preventing rusting. The author recommends several improvements in painting procedure and suggests subjects for further research on atmospheric corrosion, soil corrosion, marine corrosion, etc.

On the whole, any reader who glances through the book will be highly impressed with its extensive scope and the very efficient manner in which the mass of details worked out by the main Committee have been condensed into easily understandable matter. One has no hesitation in stating that the book should prove of great service to all who are to deal with the manufacture, fabrication or sale of ferrous products.

D. V. KRISHNA RAO.

Sedimentary Petrography. By H. B. Milner. (Thomas Murby & Co., London), 1940. Third edition. Pp. xviii + 666, 100 figures, 52 plates. Price 45*sh.*

This well-known book has now reached a third edition. The second edition, published in 1929, had 514 pages, whereas the latest edition has increased to 666 pages of

a larger size (5" × 8½"). New detail has been added to all the old chapters, and chapters now appearing for the first time include one on physical examination by means of X-Ray Crystal and Spectrum analysis, Fluorescence, etc., and two on the study of soils and applied sedimentary petrology.

It is impossible to review in detail the wealth of material present in this book, familiar in any case to those who have used the earlier editions. Its author has not only added to knowledge of the broader principles underlying the distribution and provenance of detritals, but has worked extensively on the commercial applications of sedimentary petrology. It is this combination of research with purely scientific motives and research on economic problems which is so valuable, leading to an appreciation of what methods are ideally desirable, and what, as in the case of daily routine work in petroleum geology, are actually attainable. Particularly interesting chapters on the more academic aspects of the subject are those discussing principles of correlation and palæogeographical problems, while the practical applications are seen in accounts of oil sand differentiation and correlation, soil study, and applied sedimentary petrology. The asphalt industry building and cement technology, refractories, ceramics and even forensic geology are all briefly discussed.

Many of the methods outlined in this book take much time, and cannot be carried out by field geologists who, in the course of a single season, may have to examine igneous, sedimentary and metamorphic rocks, as well as ore deposits and problems of water supply. The final comprehensive study of the separate aspects of the field geologists' work tends increasingly to be handed over to a body of specialists, more or less permanently stationed in laboratories. There is perhaps a danger in this division of labour and specialisation, and in the multiplicity of elaborate devices required to establish the nature of a single grain, essential though such technique is. But specialisation has invaded geology in the same way as the other sciences, and for any adequate understanding of regional geology collaboration between field geologists and laboratory specialists becomes increasingly necessary.

In India, where distances are great and research grants in universities are small, research in sedimentary petrography would seem to offer increasing scope for students who cannot afford to carry out extensive mapping in interesting but out of way places. It may be hoped that co-operation between the universities and the Geological Survey of India may further develop in the future. In the field of sedimentary petrography there should result valuable generalisations about the manner of formation of the Purana and Gondwana sediments. Oil companies have already done much work on the tertiary formations, but the results lie for the most part buried in competitive secrecy.

As is customary in Murby's geological publications, the illustrations are excellent. The photomicrographs of individual mineral grains are one of the most striking and helpful features of the book. It only remains to state that the latest edition of this book is essential for any research work carried out on sediments.

J. B. Auden.

Classical and Modern Physics. By Harvey E. White. (Chapman & Hall, Ltd., London), 1940. Pp. 712. Price 21*sh.* net.

The title of this book may lead one to imagine that it is one of the now fairly numerous publications concerned with what is styled as a 'philosophical' discussion of the classical and quantum mechanical aspects of physics. Really, however, it is an elementary text and as the author puts it "a descriptive introduction" to the fundamentals of physics. Prof. H. E. White, who is the author of an excellent treatise on 'atomic spectra', which is much valued by all serious students of spectroscopy, has found time to produce an elementary textbook in which 'that phase of natural phenomena now classified as modern physics and atomic structure has been treated in greater detail' than is done in ordinary physics text-books. The treatment is mainly descriptive, all complicated mathematical processes including the calculus being scrupulously avoided. In addition to the usual subject-matter found in elementary texts, there are chapters devoted to X-rays, radioactivity, photo-electricity, cosmic rays, artificial atomic disintegration including the latest discovery of nuclear fission. The concluding sections of the book deal with astrophysics—the sun, the stars and the theory of relativity.

Each chapter deals with an historical account of the discovery followed by an experimental demonstration of the phenomenon, practical applications and a short account of the accepted theory. A set of questions and simple numerical problems

based on the subject-matter of the text are included at the end of every chapter. The book is profusely illustrated with excellently drawn sketches and good photographs. As a thoroughly sound and up-to-date elementary exposition of the fundamentals of physics, both in its so-called classical and modern aspects, the book under review will have few rivals. Teachers of physics in intermediate and technical colleges will find it an excellent reference book. The author has demonstrated that it is possible to present to the beginner the fundamentals of modern physics in an entertaining and intelligible manner, without using much mathematics. Scientists, whose specialised activity is in branches of science other than physics and who wish to gain a clear understanding of the essence of all present-day discoveries in the field of physics, will find this book of inestimable value.

C. K. S.

A Text-Book of Sound for B.Sc. Students. By R. N. Ghosh and R. N. Rai. (The Indian Press, Allahabad), 1940. Pp. 353. Price Rs. 5.

Advanced science text-books written by Indians to suit Indian conditions have been very rare in the past. It is fairly recently that the enterprising publishers of the present book started to remedy this defect by publishing the now well-known treatise on heat by Saha and Srivastava. This they followed up with Saha and Saha's *Modern Physics*, and other text-books have since been issued by the same firm. The present book is a welcome addition to Indian scientific literature, and is on the whole a praiseworthy attempt to put before B.Sc. students not merely a digest of older text-books but a good introduction to most of the modern developments in acoustics, both scientific and technical. The Calculus is sparingly used and the derivations of formulæ rest on a good discussion of the underlying physical principles. Occasional references to ancient Hindu ideas relating to the subject and some discussion of Indian music and musical instruments add to the value of the book. At the ends of some of the chapters brief biographical sketches of famous men of science who have enriched the subject of Sound have been given and photographs of some of these men enliven some corners of the book. The arrangement of the subject-matter is fairly logical but the many forward references to matter treated later on could reasonably be expected to be minimised. The get-up is good and the printing satisfactory, though we think Indian presses are capable of even better work. There is a large number of mistakes and misprints which require correction; we have made a list numbering about 60. Some faulty turns of expression such as: "we have described above the ear," "Aircrafts," "experiments were carried in a room," "cause the diaphragm to vibration," etc., incorrect spelling such as: "Tympanium," "Stethescope," "Kriger Menzel," "Tortional," "Aelian," "Whetstone bridge," etc., and some wrong statements like "10 micro-watts or 100 ergs," $\frac{(\cdot 0002)^2}{40}$ ergs $= 10^{-16}$ watts," "g = force due to gravity," etc., require immediate correction. The matter included in the book, though highly interesting, may prove too much for adequate treatment in a B.Sc. class. But much of it may safely be left to the student himself to master, since the presentation is usually simple. In fact the book may be warmly recommended for the use of B.Sc. students; it really and adequately fills a lacuna that existed in the scientific literature available to Indian students.

T. S. SUBBARAYA.

The Manufacture of Compressed Yeast. By F. G. Walter. (Chapman & Hall, Ltd., London), 1940. Pp. viii + 254. Price 15*sh*.

The commercial production of compressed yeast, an organism known to man for ages, is one of the brilliant achievements of applied science. To the man of pure science, this little, microscopic, unicellular organism, had offered one of the most fruitful and fascinating fields of scientific endeavour. Year after year, there has been a steady and ever-increasing stream of contributions to our knowledge of this organism.

Yeast has given mankind not only the time-old and exhilerating liquors but has revealed to the scientific investigator that it constitutes one of the richest sources of enzymes, vitamins and other fine biochemicals. Recent work has established the virtues of yeast therapy in the prevention and cure of some of the major deficiency diseases.

Thanks to these discoveries, the yeast, to-day, has attained the dignity of a commercial product and constitutes the principal raw material for a number of vitaminised foods and fine chemicals.

The volume under review is a contribution to the applied science of yeast

manufacture. The author has presented a comprehensive description of the various methods employed in the cultivation of yeast. The fundamental principles involved in each of the processes—mashing, wort making, aeration, etc.—are discussed and their application to large-scale practice illustrated.

The raw materials and their conversion into yeast foods and methods of enriching them, are described in a manner, extremely helpful and suggestive to the manufacturer. The author has given a description of the plant and for the more important units, the constructional details are presented.

This is an extremely useful and highly practical volume; yeast is a crop of great economic value to the community providing as it does, a rich and inexpensive source of an important class of vitamins, which might be employed for enriching and fortifying the vitamin-deficient diets of this country. India has the necessary raw material for the manufacture of compressed yeast, in the form of molasses. Those interested, in the conversion of molasses into a useful product, will find this volume indispensable.

M. S.

A Text-Book of Zoology. By T. J. Parker and W. A. Haswell. Sixth edition. Vol. 2. Revised by C. Forster-Cooper. (Macmillan & Co., Ltd., London), 1940. Pp. xxiii + 758. Price 36*sh*.

With the growing need for a more up-to-date knowledge of Zoology, it was essential that the famous text-book known throughout the world as "Parker and Haswell" be revised and the first volume of the sixth edition of this work was reviewed in September last (*Curr. Sci.*, 1940, 9, No. 9, 425). A change in the contents as well as appearance was the natural result of this revision. The second volume (Chordata) follows the same plan. The type method of treatment for which the work has been so famous has been maintained and within the bounds of this general plan it has been possible to revise the text. And none better could have been found for this task than Dr. C. Forster-Cooper, who, by virtue of his position as the Director of the British Museum (Natural History) was most eminently suited to undertake it. It is clear that Dr. Forster-Cooper has been hampered by the limitations imposed on him by the general plan of the original work whose form he had to maintain and which has clearly imposed on him a restriction of scope as well as of method. But for this, Dr. Forster-Cooper's work would have been even greater. But then, it would not have been "Parker and Haswell". He has however, boldly excised from the book the chapters on geographical distribution, Philosophy of Zoology, History of Zoology and such general considerations. It would have, for one thing, been impossible to condense these into the very little space available; for another, while there are a number of recent books dealing with the above subjects which place these general topics within easy reach of the student for whose standard "Parker and Haswell" is meant, no useful purpose would be served by incorporating these voluminous theories into a text-book. This has made "Parker and Haswell" a strictly morphological treatise, and that, we believe, was the original intention of the authors.

The first striking change that meets the eye of the student is the newer schemes of classification adopted in the book. Nothing causes more annoyance and confusion to the young mind than the diversity of nomenclature and classification that is met with in zoological treatises, some incorporating new ideas in classification, others fighting shy of them and retaining the old ones. It is here that a popular, useful and established text-book like "Parker and Haswell" can pursue as well as set a definite policy in the matter of the adoption of newer schemes of classification for lesser books to follow. Dr. Forster-Cooper has done this with distinctive success and it is hoped that much of the confusion caused by the multiplicity of the schemes will be dispelled.

Detailed considerations of Palæontology of vertebrates too would occupy too much space and would unnecessarily overburden the text and even here, newer publications specially devoted to this branch of study could easily be consulted by the interested student. This is especially so with regard to the extinct groups of fishes, reptiles and mammals whose forms are so many and so varied that not to deal with all or most of them would amount to not dealing with any of them. But Dr. Forster-Cooper has utilised our knowledge of these groups to summarize the present position regarding their interrelationships. The agnathous fishes have been dealt with at length and the number of recently described fossil forms have been treated in detail, because they form, for a clear understanding of the fishes

in general, a perfect introductory note. The classification of fishes has been revised and brought up to date.

Much light has recently been thrown on the structure of the skull of reptiles, both extinct and modern, and the temporal region of the skull provides the key for a correct understanding of the phylogeny of the group. In a series of diagrams drawn specially for the book, Dr. Forster-Cooper has shown the relative arrangement of the different bones of the skull in the several orders and has traced the ancestry of the avian and mammalian temporal regions. The lower jaw of the fossil reptiles is another feature which has lent itself for a discussion of the ancestry of higher vertebrates and Dr. Forster-Cooper has summarized our knowledge of the structure and phylogeny of the reptilian lower jaw.

The treatment of birds has not undergone any considerable change and in fact the rather limited scope of the work has precluded the consideration of the varied natural history and the diverse adaptations of these animals and the student is referred to one or the other of the numerous books on the subject. But, we ask, is any treatment of birds complete without an account of their migration, their parental instincts and their marvellous adaptations to different modes of life? In our opinion the book is the poorer for the exclusion of these interesting facets of bird life.

Mammals have received wide attention at the hands of the reviser. The young student's heart will jump at the enumeration in serial order of the characters of the typical mammal. A very detailed account of the Prototheria and Metatheria presents the salient features of these groups and provides the student with adequate information regarding these two zoologically interesting sub-classes.

In the classification of the mammalia the fossil groups like Allotheria, Triconodonta, Symmetrodonta and Pantotheria have been included along with the modern forms and brief descriptions of them have been incorporated in order to present an idea of the ancestry of the modern mammals. In fact the entire treatment of the mammalia is based on the underlying idea of the appearance in time of its different classes and presents a variation over that of the older editions. Thus the former Ungulata Vera is replaced by the Perissodactyla and Artiodactyla each of which has a different ancestry and each of which has been treated as an independent order.

The format of the book also has changed for the better. The page size is larger and so is that of the types. A wider spacing of the lines presents a better appearance and makes for easier reading. The addition of over a hundred figures has been necessitated by the augmented text. The reviser as well as the publishers are to be congratulated on the production of a useful and attractive edition of this famous book.

B. R. S.

Energy and Economics—A Plea for a New View-Point. By Gilbert J. Fowler, D.Sc., F.I.C., F.R.San.I., F.N.I. (The Times of India Press, Bombay). Price 12 annas or 1*sh.*

To readers of *Current Science* this interesting brochure may present many familiar features. Dr. Gilbert Fowler in republishing the article originally contributed to this *Journal*, has furnished an "Introduction", two appendices and a supplementary bibliography relating to the subject of Energy and Economics. The Introduction, which summarises the views on the subject of a "new order" in the economic sphere, provides the most stimulating reading. It is obvious that in our society the unemployed, in the first place, are the scapegoats of an organisation which is unable to incorporate technical progress into its general social frame-work. For mechanical progress does not necessarily signify social progress. When society is thoroughly reorganised, economically and psychologically, and can keep pace with the advance of industry, is continuous improvement possible. Efforts must therefore be made to influence men to think ahead, to maintain the courage and sense of adventure which are so successfully used in the realms of service for the welfare of society. Dr. Gilbert Fowler has the faculty of thinking far ahead of his generation, and though his ideas for the economic betterment of society may at the present moment seem unorthodox, they are bound to create a general reformation in our concept of "money", "wages", "credit" and "production" which now under the influence and power of the financier, underlie all social unrest and upheaval. On page 8, there is a courageous and truthful utterance against the "money power", of England, in contrast with the German system of basing credit on the energy of the people. "It is here that the

world of science must be awakened." After all the problem of finance cannot remain long without being "brought within the domain of science or fundamental truth". "To a scientific thinker it seems absurd that the reward of any worker, be he a statesman or a scavenger, should depend on anything other than the value of his labour to the community." We agree with Dr. Fowler when he says that the solution for the social evils lies in the community control of money credit and interest and that no single individual or institution should be permitted to "affect the fortunes favourably or unfavourably of thousands of people," by "a simple manipulation of the currency". After a very careful and critical analysis of the affairs of men and money, Dr. Fowler announced the idea of the ERN, which he has elaborated in a series of articles distinguished alike for their clearness of thought and cogency of argument. "It is a definite measure of potential man power,—the daily nitrogen ration of an average human being with its equivalent energy, i.e., 10 grams of nitrogen and 300 calories of energy." Ultimately the world is bound to get rid of the tyranny of "money" and to adopt an international currency unit which would settle once and for all those factors which militate against our social and spiritual progress. Dr. Fowler has found the way. We must have the needful vision and boldness to tread that path—the path of fundamental truth.

Experiments for the Haveli Project on a model of the rivers Jhelum and Chenab downstream of their confluence. By Dr. N. K. Bose and L. Thakar Dass Gulati. (Punjab Research Institute Research Publication), 1940. Vol. II, No. 24. Pp. 58. Price Rs. 1–8.

Before undertaking the construction of the Emerson Barrage across the river Chenab, experiments were conducted on a model of the rivers Jhelum and Chenab downstream of their confluence with a view to investigate the best orientation of the weir at the proposed site, the best position and shape of the guide banks, leading diversion cuts to the weir and the height of training works and embankments.

The model was built to a horizontal scale of $^1/_{300}$ limited by the available land at Malikpur and to a vertical scale of $^1/_{50}$. A time scale of 10 min. = 1 month was found to give the best reproduction of the 1936 cross-section starting from the 1915 cross-section, when the model was run with different discharges based on a discharge curve prepared by taking ten-day averages from hydrographs of the two rivers from the year 1922 onwards. Silt of the same grade as in the river was injected, half a cubic foot of silt for floods bigger than 150,000 cusecs and quarter cubic foot for floods between 80,000 and 150,000 cusecs and no silt was injected for lower discharges.

Experiments were conducted to study the behaviour of the river during the construction, diversion and post-diversion periods. During the construction period run, the right outside ring between the weir site and the main river was attacked by the river during heavy flood and a radial spur was put in to protect the bund.

A retired embankment was thrown across the river and leading cuts were introduced upstream and downstream of the weir. The model was run for 5 years corresponding to 1939 to 1943—the discharges being those of 1929 to 1933. After the run, the river downstream of the weir was found to follow its old right-hand course. The right guide bank was undermined at the upstream and downstream noses. The main stream struck the weir centrally, passed around the noses of the divide walls undermining them and carried silt into the pockets and finally into the canal. Belas were formed on the inside of the right guide bank upstream of the right divide wall and in the right river pocket.

The right guide bank was modified and turned round to control the bela formation. In the next diversion run the mainstream was led through a cut 300 feet wide, cuts leading to the centre of the weir and to the sluices were each 150 feet wide and the downstream cuts were all 300 feet wide. The model was run as before for five years corresponding to 1939 to 1943. During this run, the left-hand branch of the river downstream of the weir and the right-hand branch above the weir developed, the bela formed in the previous run almost disappeared and there was no scour at the nose of the right divide wall. There was a deep scour at the nose of the left divide wall due to the main current entering the pocket from the right of the divide wall, instead of directly into it. This defect due to the river approaching the weir at an angle could be overcome by turning the weir-line through 10° to 15° about its right

end till the left end was moved upstream to the nose of the left divide wall when the weir would be normal to the main stream with the pockets getting a straight current.

The construction of the Emerson Barrage was started after the above experiments were carried out. Model experiments not only indicated a suitable design but prevented the adoption of faulty designs entailing possible future expenditure on protective and remedial measures.

C. GOPALAKRISHNAN.

AGRICULTURE IN AFGHANISTAN

WE owe the following brief summary of the agricultural features of Afghanistan and of the directions in which development is possible to extracts from the report of the Indian Agricultural Delegation which visited that country in the year 1939. The area fit for cultivation is said to be less than a quarter of the total extent of the country which is 270,000 square miles, mostly mountainous in character. The average height is about 3,000 feet and the central valleys are over 6,500 feet above sea-level. The rivers flow through deep gorges, are snow fed and liable to sudden spates. A peculiarity of these rivers is that as they get farther from their sources they dwindle away and get lost in the soil. The average annual rainfall including snowfall is only between 12 and 15 inches and in certain places no more than 2½ inches. The climate varies between an Alpine one in the north-east to a hot desert one in the south-west. The soils are on the whole fertile and under irrigation yield an abundant harvest. Irrigation is from streams, springs and from what are called "kerezes". The inhabitants are engaged mostly in agriculture and pastoral pursuits.

It is as a fruit-growing country that Afghanistan has impressed the Delegation and many useful suggestions are given for developing this industry on proper lines. These relate to the introduction of citrus fruits and of loquats, figs, and canning peaches, of better varieties as regards both quality and yield, of improved planting methods and pruning and to the control of insect pests and diseases. Improvements in propagation methods are indicated with special reference to suitable stocks from East Malling and elsewhere. Alongside of the fruit-growing industry is stressed the need for developing the fruit-products industry and for this purpose a fruit products laboratory is recommended to be opened under Government auspices. Among other crops, cotton has made great progress, the staple is suited for 60 counts and the crop is remarkably free from diseases and pests. Sugar beet is extensively grown and a beet sugar factory is under construction. Its progress will depend upon the extent to which diseases can be kept under control. Wheat is the most extensively grown crop but it is subject to both rust and smut; the breeding of higher yielding and disease-resistant types is recommended. Large tracts are under rice and the Delegation thinks that the area may be reduced and money crops like cotton, tobacco, fruit, etc., may be substituted. Experiments with a view to establishing the cultivation of cigarette tobacco are suggested and an increase in the cultivation of potatoes is recommended especially because the cold climate will enable the country to meet the large Indian demand for both seed and table potatoes admirably. Artemesia is growing wild and an examination of its quality as a source of santonin is suggested. As mulberry grows extensively in the country the development of sericulture forms another recommendation. Likewise attention is drawn to the introduction of the bee-keeping industry both as an aid to fruit cultivation and as an independent source of income. The cultivation of berseem is desirable for fodder and green manure and also as a source of seed supply to India. Irrigation, artificial manures, and improved implements are briefly touched upon, with a keynote of caution. The Delegation on the whole has been so greatly struck with the agricultural possibilities of Afghanistan as to observe that "Its agricultural potentialities are immense" and that "it is round agriculture that the future prosperity and well-being of the country will revolve".

A. K. Y.

CENTENARIES

Dewees, William Potts (1768–1841)

WILLIAM POTTS DEWEES, an American obstetrician, was born May 5, 1768, near Pottstown, founded by his maternal grandfather, Thomas Potts. After school education, he studied medicine in the University of Pennsylvania from 1787 to 1789 and became M.D. in 1806 on the basis of his thesis *An essay on the means of lessening pain and facilitating certain cases of difficult parturition.* He began private practice in 1790.

At that time obstetrics had not received attention from the profession and the majority of deliveries were in the hands of midwives. Nor was there any formal teaching in the subject. There was a strong prejudice against 'men midwives'. Indeed Laurence Sterne's picture of Dr. Slop in *Tristram Shandy* is an index of the derision to which the man midwife was subjected. In spite of it Dewees had the courage to teach the subject and practise it. Very soon he became popular and it is said that he delivered over ten thousand women.

By and by, public opinion veered round and a professorship of obstetrics was created in Pennsylvania. But a less competent rival of Dewees was preferred. This and other disappointments shattered his health and tuberculosis developed. Hence he gave up practice and took to agriculture at Phillipsburgh. Though this venture proved a failure, he regained his health and resumed practice in 1817. He was also made additional professor in 1825. After he became chief professor in 1835 and thus realised his frustrated ambition, he developed cerebral hemorrhage and had to resign his professorship.

His chief work was *A compendious system of midwifery,* which though published posthumously, went through twelve editions. He also published volumes on gynæcology and general medicine.

Dewees died at Philadelphia May 20, 1841.

Radcliffe, William (1760–1841)

WILLIAM RADCLIFFE, a British textile inventor, was born October 17, 1760, at Mellor, Derbyshire. His father being a weaver, he learnt carding, spinning and weaving at home and began business in his own village. Later in 1801 he settled at Stockport. He opposed the export of yarn to the continent on the ground that it deprived local weavers of their vocation. On this he published in 1811 a pamphlet entitled *Exportation of cotton yarns the real cause of the distress that had fallen upon the cotton trade for a series of years past.*

With the help of one of his mechanists, he invented the 'dressing machine' by which the warp could be dressed or starched before being put into the loom. This and other inventions of his resulted in the saving of much time. But the great expense he incurred in his experiments ruined him and he became bankrupt in 1807.

With the help of some friends, he again started business; but broke down again in 1815. His life was thereafter one of adversity. In 1820 he published an account of his struggles under the title *Origin of the new system of manufacture commonly called power-loom weaving, and the purposes for which this system was invented and brought into use fully explained.* Efforts were made in 1825 to secure a parliamentary grant for him on the ground that his invention "by removing the impediments to weaving by power, may be considered as the cause of rapid and increasing growth of that system of manufacturing cotton goods". They did not then bear fruit. Several firms however gave him a royalty and ultimately a small grant of £150 was made by government. But the intimation came only three days before his death, which took place May 20, 1841.

S. R. RANGANATHAN
University Library
Madras

SCIENCE NOTES AND NEWS

Photo-Fission of Uranium and Thorium.—Hahn and Strassmann's discovery of the neutron-induced fission of uranium atoms resulting in two fragments of nearly equal masses early in 1939 was quite a sensational piece of scientific news. Scientists were therefore well prepared in 1940 for the preliminary announcement from the Westinghouse Research Laboratories, East Pittsburgh, Pennsylvania, that uranium and thorium atoms behaved similarly under the influence of energetic γ-rays. The discoverers of this phenomenon of photo-fission, R. O. Haxby, W. E. Shoupp, W. E. Stephens and W. H. Wells have recently (*Phys. Rev.*, 1941, 59, 57) given a fuller account of their findings. High energy protons (2–3 Mev.) from the Westinghouse electrostatic generator were, after magnetic analysis, directed on to a CaF_2 target in a Faraday cage. The bombardment of fluorine gave rise of γ-radiation of the required energy (about 5 Mev.), which in turn irradiated a 12 cm.^{2} piece of uranium metal, placed on the high voltage plate of the ionisation chamber. The authors have thereby measured the cross-sections for the photo-fission of uranium as well as thorium and find that

$$\sigma_U = 3{\cdot}5 \times 10^{-27} \text{ cm.}^2 \text{ and}$$
$$\sigma_{Th} = 1{\cdot}7 \times 10^{-27} \text{ cm.}^2,$$

with a probable error of about 30 per cent. The fission of the heavy nucleus is thus not a frequent happening. The chance that one quantum of γ-rays per cm.^{2} will cause the fission of one atom of uranium is $3{\cdot}5 \times 10^{-27}$. Under comparable circumstances, the cross-section of the uranium atom for fission by slow neutrons would be about 3×10^{-24} cm.^{2} Thus the neutron-induced fission is roughly 1,000 times as probable as the photo-fission. These recent experimental values for the cross-sections in photo-fission agree well with the theoretical estimates by Bohr and Wheeler.

L. S.

Electrostatic Generator and Transmutation of Fluorine.—In the February issue of the *Physical Review* (1941, 59, 241) Tom Lauritsen, C. C. Lauritsen and W. A. Fowler have published the details of construction of a pressure electrostatic generator that they have erected in the Kellogg Radiation Laboratory of the California Institute of Technology, Pasadena. A brief review of the details of this generator with the diagrams (reproduced by permission) has been attempted in the columns of *Current Science* (1941, 10, 124) by C. K. Sundarachar, J. F. Streib and B. V. Raghavendra Rao. Complete details regarding the design of the generator, the high potential electrode, the pressure vessel, the supporting and insulating columns, the charging system, the ion source and the accelerating tube are now directly available from the Kellogg Laboratory for those interested in the construction of a similar generator in India. The dependence of the terminal voltage on the charging current as well as the relation between the maximum operating voltage and the tank pressure have been studied. The performance of this generator which operates at 1·7 Mv. in a cylindrical tank of over-all length 13′ 6″ and diameter 8′ at a pressure of 80 lb. per square inch is discussed. The transmutation of fluorine by protons accelerated to high velocities by the generator has been examined by J. F. Streib, W. A. Fowler and C. C. Lauritsen (*Phys. Rev.*, 1941, 59, 253). The origin of the γ-rays given off when fluorine is bombarded by fast protons is traced to the reaction

$$F^{19} + H^1 \rightarrow {}^{\gamma}Ne^{20} \rightarrow {}^{\gamma}O^{16} + He^4$$
$${}^{\gamma}O^{16} \rightarrow O^{16} + h\gamma,$$

where the superscript γ refers to states of Ne^{20} or O^{16} involved in the production of the 6·2 Mev. γ-radiation. The γ-radiation has been shown to exhibit resonance at proton bombarding energies of 0·334, 0·479, 0·589, 0·660, 0·862, 0·927, 1·335 and 1·363 Mev. thereby leading to a discussion of the nuclear energy levels of the intermediate products; the emission of the short-range α-particles has been definitely established.

L. S.

The Growth and Food of Young Salmon.—An account of the growth of Salmon based on observational data in 220 Salmon smolts and parr captured during a period of 8½ years has recently been published by Went (*Proc. Roy. Irish Acad.*, 1940, 46 B, 53). Of the specimens collected, males comprised 62·8 per cent. and of these, 46·5 per cent. were sexually mature. Some smolts of the two-year class which showed signs of rapid growth migrated first, showing that the migration of smolts depends on some physiological condition which is associated with the attainment of a minimum size. The Salmon grew less rapidly than the brown trout and the scales indicated that the "Summer" or rapid growth was from April to end of July. Careful observations have revealed that it would be impossible to use the scale method for determining the proportion of sexually mature fry or to say from the adult scales whether the male had spawned during its parr life.

In the same paper, Frost has reported on the food contents of 192 Salmon parr and smolts ranging in length from 9 to 18·5 cm. Different age groups showed no significant differences except that the larger Salmon ate winged Ephemeroptera. As the trout feeds mostly on aquatic insect larvæ the author suggests that in the River Liffey the competition for food between the Salmon and trout will chiefly be for these larvæ.

R. G.

The Marketing of Potatoes in India.—The report on the marketing of potatoes in India recently issued by the Agricultural Marketing Adviser to the Government of India maintains the high standard of thoroughness which we are now accustomed to associate with these marketing surveys and reports. It deals with

the subject on the comprehensive plan which has now been standardised for these reports, all the main aspects of supply, demand and distribution being fully examined and reported upon and suitable recommendations for improvement under all heads also made. The total annual production of potatoes in India is reported to be 491 lakhs of maunds worth about nine and a half crores of rupees. There is in addition an import of 11½ lakhs of maunds worth over Rs. 33 lakhs. The area estimated as 448,000 acres is concentrated in the United Provinces, Bihar, Bengal and Assam, which together account for 80 per cent. of the acreage. About 90 per cent. is grown in the plains and the remainder on the hills; the former being mainly a winter grown crop and the latter summer grown. One of the most important problems is that relating to the storage of the produce over some months for its sale as table potatoes and as seed. The loss in the present methods of storage and handling is enormous and its money value is estimated at over a crore and a half of rupees. Prices at harvest time are only Rs. 1–8 to Rs. 2–8 a maund but they soar to Rs. 5 to Rs. 14 per maund after six months—a fact which shows the advantage of storage and the need for preventing the deterioration and loss. Much of the imports are for seed purposes and the high price of seed imported or locally grown and stored as compared with the price of ordinary produce is one of the heavy handicaps to potato cultivation. The subject of storage methods including cold storage is gone into as fully as its importance deserves. Railway transport charges are said to be very high and the use of the ordinary steel waggons leads to damage in transport; a reduction in the tariff of charges and the substitution of wooden vans for steel ones are suggested. The formation of co-operative societies of growers for the joint purchase of seed, and for looking after the financial and other needs of the members is recommended. Regulated markets, standardisation of weights and measures and the grading of potatoes according to sizes, shapes, colour and quality as well the use of standard forms of packages, and finally, on the side of research, the production of varieties with better keeping qualities, shorter periods of growth and of dormancy, disease-resistant and high yielding are among the many other useful recommendations.

A. K. Y.

Flora of the Punjab Plains.—An account of the Flora of the Punjab Plains and the Associated Hill Regions has been recently published by Dr. T. S. Sabnis (*J. Bombay Nat. Hist. Soc.*, 1940, 42, 124–49). In preparing this compilation, the author has obtained much useful information from the published papers of previous workers on the floras of the Punjab and from an examination of the collections in the Herbarium of the Forest Research Institute, Dehra Dun. The contribution refers only to a part of the flora of the Punjab plains and associated hill regions. According to Dr. Sabnis, the Punjab flora "represents 118 families which include 530 genera and 949 species" while actually the number of families, genera and species listed in the paper are 39, 105 and 189 respectively. The reason for this discrepancy is not clear. Further in numbering the families, No. 13 has been missed so that the total number of families described is 38 and not 39. Dr. Sabnis's contribution on the flora of the Punjab plains, etc., is incomplete in that such important families of the dicotyledneæ as Compositæ, Convolvulaceæ, Acanthaceæ, Euphorbiaceæ and others are omitted. Not a single monocotyledonous family is included. We trust that this discrepancy will be made up by the publication of a supplementary list.

L.S.S.K.

Indian Vegetable Oils as Fuels for Diesel Engines.—The annual production of vegetable oils in India is about eight million tons. Although at present the market prices of vegetable oils are in general higher than that of mineral Diesel oils, in certain localities, particularly the non-edible oils are available at fairly cheap rates, and it is quite probable that at a not too distant future, the relative prices of the vegetable and mineral oils may be reversed. It is therefore of great national importance to investigate the utilisation of vegetable oils as Diesel engine fuels. The results obtained by the Indian Research Bureau indicate that most of the vegetable oils may be successfully employed as Diesel fuels (*Bull. Ind. Res. Bureau*, 1940, No. 19. By H. D. Chowdhury, S. N. Mukherji, J. S. Agarwal and Lal C. Verman). Some do not require any modification in the engine except minor adjustments; such oils include groundnut oil, cotton seed oil, and rape seed oil. Cotton seed oil gives an exceptional performance in that its consumption is definitely less than that of mineral oils, and its efficiency appreciably higher, while the power output is equal to that obtained in the case of mineral oil.

The Indian Glass Industry.—With an annual production valued at Rs. 2,00,00,00,000 India's 101 glass factories are now able to meet national requirements to the extent of over 50 per cent. of the annual consumption. This figure may rise rapidly as further results of industrial research are made available to the industry.

The Board of Scientific and Industrial Research is further considering improvements in the furnaces designed at the suggestion of the former Industrial Research Bureau. As a result of stimulus given by the Bureau, a number of firms began to manufacture and market China glass. The possibilities of manufacturing liquid gold were indicated in a Bulletin of the Bureau (Bull. No. 17).

Good neutral glass is now being manufactured in Calcutta and satisfactory laboratoryware is now being produced. The requirements of the pharmaceutical industry and the medical services would soon be met by the glass produced in the Indian factories.

With the introduction of modern methods, new lines of manufacture are now open, such as beads, false pearls, ornamental glass plates, lampware, phials and tableware. The Glass and Refractories Committee of the Board of Scientific and Industrial Research is investigating the

production of optical glass and already certain samples have been prepared which have been reported to be fairly satisfactory especially for making binoculars and lenses.

Archaeological Survey of India.—In the field of exploration the most important discovery was that of a colossal temple with multiple terraces and angles datable to the early centuries of the Christian era at Lauriya Nandangarh in Bihar, says the *Annual Report of the Archæological Survey of India for the year* 1936–37 just published. This temple is the earliest prototype of the architecture of Burma, Java and Siam. The work was carried out by the late Mr. N. G. Majumdar, whose premature death has deprived Indian archæology of a devoted explorer.

A number of ruins were also explored in the jungles of Assam, which still hold some surprises for the archæologist.

During the year under report the Gol Gumbaz at Bijapur, the biggest dome in India, was reconditioned and special repairs to Taj Mahal at Agra, the Imambara of Asaf-ud-Daula at Lucknow and the ancient Buddhist ruins at Sarnath near Benares were carried out.

In the epigraphical branch the most important discovery is that of the earliest inscriptions found with three Barhmi inscriptions from Kosam, ancient Kausambi in the Allahabad District, one of which dates from the second Century B.C. Much material was collected in Central India, Rajputana and South India. A specially important feature of this year's collection is the discovery of a number of copper-plate records which throw interesting light on the history of early and mediæval India.

In the field of Museums, great improvements were recorded in the acquisition and rearrangement of departmental museums. A detailed scheme whereby a number of museums in all Provinces throughout the country should benefit by receiving duplicate representative sets from Mohenjodaro was launched during the year. This work has been steadily going on and is much appreciated by the authorities in charge of the Provincial Museums.

Botanical Survey of India.—The collection and dissemination of all available information regarding several plants of economic importance; a thorough study of the possibilities of cultivating ipecac; the development of the tung-oil industry and the use of water-chestnut as a food product are among the activities referred to in the Annual Report of the Botanical Survey of India for the year 1939–40.

Nearly 3,500 specimens were identified and revised during the year; of these about 800 plants belonged to the Forest Research Institute, Dehra Dun, and 702 Burmese specimens were received from Dr. E. D. Merrill of Harvard University, U.S.A. The rest were sent by various Government Departments and educational institutions and private workers in India and abroad.

A large number of exhibits has been added to the already rich collection of specimens in the public gallery of the Industrial Section of the Indian Museum. Among them are Indian silk products, industrial oils and oilseeds, food products, plant specimens of reputed insecticidal properties, hand-made paper exhibits and medicinal plant products.

Both the Herbarium and the Library have been enriched by new collections and acquisitions of suitable literature.

Workers in universities and other institutions both in India and abroad were supplied with different plant materials for their research work and the results obtained were in most cases communicated and recorded.

Correspondents, mainly from the commercial public, were supplied with information on the sources and supply of economic plant products, such as fibre, resins, tanning materials, varnish oil, vegetable dyes, insecticides and medicinal plants.

Imperial Veterinary Research Institute.—The Annual Report for the year 1939–40 issued during this month draws attention to the expanding activities of this institution, which not only provides facilities for research in veterinary science but also provides instruction to post-graduate students in advanced animal husbandry including poultry husbandry. Arrangements have been made to set up a central museum at Izatnagar with a view to give the visitors a scientific insight into the field now covered by veterinary science. It is also proposed to establish a Wool Research Laboratory and a laboratory for investigating problems connected with hides and skins.

The Poultry Research Section of the Institute at Izatnagar has been the central agency for promoting interest in poultry farming by research, advisory work and instruction to students. In this section, long-term breeding and nutrition experiments have been started. Of the poultry diseases studied, mention may be made of Fowl *spirochætosis* and infection with *Sp. anserina*. Birds infected with the latter, have been successfully treated with atoxyl.

In the Animal Nutrition Section surveys of animal nutrition in villages have been conducted. The examination of cattle feeds suitable for famine areas and experiments on the drying of grass, etc., are being carried out. The study of the more common cattle diseases including rinderpest was continued. It was observed that the vitamin C content of tissues of animals was greatly reduced in certain diseases like rinderpest, worm infectation (in horses), etc. As farm animals are known to be capable of securing their own vitamin C requirements, independent of the diet, this observation is of particular interest. The problem is being investigated in detail.

The spore-vaccine issued by the Institute for the treatment of anthrax has proved very successful; animals treated with the vaccine proved immune for at least 18 months.

Industrial Research Bureau: Annual Report, 1939-40.—The achievements of the Industrial Research Council, the Industrial Research Bureau, and the Research Branch of the Government Test House, Alipore, are briefly summarised in this report. We notice that the

Industrial Intelligence Service is being increasingly availed of, and is forming a very useful activity of the Industrial Research Bureau. The principal subjects of research of the Research Branch of the Government Test House have been the improvement of paints, manufacture of dry cells, and the utilisation of Indian vegetable oils as lubricants and as fuels in internal combustion engines. Brief accounts of the progress in these as well as in a number of other subjects are given in Chapter III.

Department of Industries, Bombay.—The Annual Report for the year 1939–40 (obtainable from the Superintendent, Government Printing and Stationery, Bombay, price As. 5), indicates that the new industrial joint-stock companies floated during the year under review involve a capital of nearly Rs. 340 lakhs. Among them is a new factory for the manufacture of starch from maize with a capital of Rs. 25 lakhs, under construction in Ahmedabad. This factory also proposes to manufacture glucose, dextrine, chemical starch, gluten, food maize, germ oil, etc. It is also interesting to note that a leading American firm has invested Rs. 75 lakhs for the manufacture of car and cycle tyres, using Indian raw materials.

The Department has, as usual, vigorously helped in the solution of practical difficulties encountered in the process of manufacturing and marketing the goods of a variety of Industries in the Province, and has conducted experimental industrial work and practical demonstrations for the benefit of small-scale and cottage industries.

Prince of Wales Museum of Western India.—The Annual Report for the year 1939–40 just issued, records the activities of the Art, Archæological and Natural History Sections of this most important National institution. Several improvements have been effected in all the sections with a view to render the Museum more useful both for public instruction and research.

In consultation with expert opinion the Trustees took all necessary precautions for protecting the most valuable exhibits from possible war damage. With a view to establishing a closer co-operation between the Museum and general public and schools, it is proposed to appoint guide lecturers.

In the exhibition of arms and costumes a new and attractive feature has been introduced in the Art Section on the model of the Folk Museums of Scandinavia. Models of Mughal and Maratha officers and soldiers have been prepared in the Art Section, and are being equipped with offensive and defensive weapons of the seventeenth century and dressed with the costumes of the period. In the Natural History Section numerous models illustrating the structure of reptiles have been prepared and suitably exhibited.

Post-graduate students of the Deccan College Research Institute and other scholars were given full facilities for the study of the exhibits in the Prehistoric and Brahmanical galleries of the Archæological Section. In the Natural History Section the work of cataloguing and arranging the research collections was continued and the reference collections of reptiles and fishes were made available to Drs. Malcolm Smith and S. L. Hora, who are now engaged on a revision of the Fauna of British India (Reptiles and Fishes).

Pasteur Institute of Southern India, Coonoor.—The Annual Report of the Director for the year 1939–40 which was issued early this year, gives an account of the rapidly expanding activities of this Institute. In addition to the usual routine work, much valuable research on rabies was carried out. A notable achievement is the preparation of a clear vaccine of high immunising value obtained by the iso-electric precipitation of a large quantity of inert protein accompanying the phenol-vaccine now in use. The preparation was relatively non-toxic.

A research unit known as the Protozoal Parasites Enquiry was attached to the Pasteur Institute, Coonoor, at the end of 1938. This unit is entirely financed by the Indian Research Fund Association. The activities of this section include, the study of the mechanism of defence against malaria, the study of antibodies in the spleen and the peripheral blood of immune monkeys, and large-scale experiments with sporozoites of *P. gallinaceum* (undertaken in collaboration with the Malaria Investigations of the International Health Division of the Rockefeller Foundation working at the Pasteur Institute, Coonoor). Several new species of protozoal parasites have been encountered during the progress of the enquiry. A hitherto undescribed species of *Plasmodium* has been observed in the blood of Malabar squirrels but all attempts to transmit this parasite to other animals by blood inoculation, or to obtain a suitable insect vector, have so far failed. This work has received special attention since it is highly desirable to procure a malarial infection in some small laboratory animal. A trypanosome infection has also been discovered in the blood of the Malabar squirrel. Natural infection with a malaria parasite believed to be *P. inui* has been found in the blood of a young specimen of *S. sinicus* originating in the foothill jungles within 15 miles of Coonoor. This is the first record of this parasite in India.

Other independent units working in the Pasteur Institute are: Nutrition Research Laboratories (financed by the Indian Research Fund Association), Malaria Investigations (financed by the International Health Division of the Rockefeller Foundation) and Plague Enquiry in the Nilgiri District. The Pasteur Institute has recently carried out successful experiments on the preparation of precipitin sera for human and ox blood, as there is a considerable demand in the East for such high titre precipitin sera for the detection of blood meals taken by mosquitoes.

With a view to revive industries on vegetable dyes the **Board of Scientific and Industrial Research** has set up an exploratory committee on vegetable dyes.

As a result of the encouragement given by the Board, much useful work has already been

carried out. Work on the dyes from Kamala flowers, for use as edible colouring materials, has been completed at the H. B. Technological Institute, Cawnpore. The possibility of producing dyes from myrobalans is being studied under the auspices of the Mysore University. Experiments have been completed at the Government Textile Institute, Madras, on some natural die-yielding products of indigenous growth, the use of which was in vogue prior to the advent of synthetic dyes. The process of extraction of the colouring matter has been standardised and recipes for several shades for use with cotton, silk and wool have been drawn up.

The American Academy of Arts and Sciences has awarded the **Amory Fund** of nearly $16,000 to four investigators in consideration of their outstanding contributions to the treatment and cure of diseases of the genito-urinary system. The name of the three American recipients, announced in *Science* are: Dr. Joseph F. McCarthy, Dr. Carl Richard Moore, and Dr. Hugh H. Young. The name of the fourth recipient, who is in Europe has not been made public and his prize will be held by the Academy in trust. The Amory Fund was established in 1912. The income for the Fund is devoted to the award of a septennial prize and the prizes just awarded are the first awards from the Fund and cover the contributions made since 1933.

The Katherine Berkan Judd Prizes of $1,000 have been awarded to Drs. E. L. Kennaway and J. W. Cook of the Royal Cancer Hospital, London, for "outstanding contributions to knowledge of the cause and cure of Cancer" for the years 1939 and 1940. Dr. Kennaway isolated dibenzanthracene in crystalline form from coal tar and showed that it was active on all animals in the causation of cancer. The structural formula of the causative agent was worked out by Dr. Cook.

Imperial Agricultural Research Institute.—The Diploma of the Institute (Assoc. I.A.R.I.) has been awarded to Mr. P. R. Bhagwagar, M.Sc. (Alld.), after the completion of two-year post-graduate course in Mycology and Plant Pathology, and in consideration of his thesis entitled: Part I—*Review of Fungicides in India* (including Burma and Ceylon). Part II—*Studies in* Fusarium *Wilt and Seed-rot of Gram* (Cicer arietinum *L.*) *in India.* Part III—Alternaria *Species on Potato in India.*

Andhra University.—The Honorary Degree of *Doctor of Science* has been conferred on Rao Bahadur T. S. Venkataraman, Imperial Sugarcane Expert, Ccimbatore, and on Prof. S. Bhagavantam, Professcr of Physics, Andhra University, Waltair.

The Executive Council of the **Lucknow University**, at their meeting held on April 18, unanimously elected Kunwar Sir Maharaj Singh, Vice-Chancellor of the University. Sir Maharaj Singh will take over charge of the office on July 16.

SEISMOLOGICAL NOTES

During the month of April 1941 one great, five moderate and four slight earthquake shocks were recorded by the Colaba seismographs as against three moderate and two slight ones recorded during the same month in 1940. Details for April 1941 are given in the following table:—

Date	Intensity of the shock	Time of origin I. S. T.		Epicentral distance from Bombay	Co-ordinates of the epicentre (tentative)	Depth of Focus	Remarks
April 1941		H.	M.	(Miles)		(Miles)	
1	Moderate	16	11	6890			
3	Moderate	20	59	5210			
15	Slight	01	03	1210			
16	Great	00	40	9840	Epc: Near lat. 15° N., and long. 92° W., to the south-east border of Mexico		
18	Slight	10	53	3090			
18	Moderate	18	55	3090			
19	Moderate	13	24	2010	Epc: Near lat. 40° N., long. 97°·5 E. in the neighbourhood of Su-chow in Kan-Su, China		
20	Moderate	23	09	1420	Epc: Near lat. 39°·7 N., long. 75° E., near Kashgar in Sin-kiang, China		
27	Slight	04	41	1490			
30	Slight	15	16	4290			

ASTRONOMICAL NOTES

The Sun will be at the summer solstice on June 22, when it reaches its most northerly position.

Planets during June 1941.—Both Mercury and Venus will be low down in the western sky at sunset; the former attains its greatest apparent distance from the Sun (23° 47′ E.) on June 6 and can be easily seen as a reddish star of magnitude 0·6 during the first half of the month. Mars is in quadrature with the Sun on June 2. It is in the constellation Aquarius and will be visible as a red star very near the meridian at sunrise. Its stellar magnitude at the end of the month will be −0·4. The three planets, Jupiter, Saturn and Uranus, are all morning stars rising only a short while before the Sun and are not favourably situated for observation.

Omicron Ceti (Mira).—The next maximum brightness of this interesting variable is expected to occur about June 25, when the star is likely to be of the second magnitude. The position is R.A. $2^h\ 16^m$, Declination 3° 15′ S. It is one of the best known of the long period variables, the range of variation being nearly eight magnitudes and period 331·8 days. The star is of a deep red colour, and at maximum, can be easily located as a bright second magnitude star a little to the south-west of the stars α and γ Ceti. T. P. B.

ACKNOWLEDGEMENTS

We acknowledge with thanks the receipt of the following:—

"Journal of the Royal Society of Arts," Vol. 89, Nos. 4579 and 4581.

"Journal of Agricultural Research," Vol. 61, Nos. 9–11.

"Agricultural Gazette of New South Wales," Vol. 52, Part 3.

"Contributions from Boyce Thompson Institute," Vol. 11, No. 6.

"The Journal of Chemical Physics," Vol. 9, No. 3.

"Journal of the Indian Chemical Society," Vol. 18, No. 1.

"Experiment Station Record," Vol. 84, Nos. 2–3.

"Indian Forester," Vol. 67, No. 5.

"Transactions of the Faraday Society," Vol. 37, Parts 1 and 2.

"Indian Farming," Vol. 2, No. 4.

"Geological, Mining and Metallurgical Society of India" (Journal), Vol. 12, No. 3.

"The Hyderabad Academy Studies," No. 2 (1940).

"Indian Central Jute Committee" (Bulletin), Vol. 4, No. 1.

"Bulletin of the American Meteorological Society," Vol. 22, No. 1.

"The Indian Medical Gazette," Vol. 76, No. 4.

"Journal of Nutrition," Vol. 21, No. 3.

"American Museum of Natural History," Vol. 47, No. 3.

"Nature," Vol. 147, Nos. 3716–18, 3720, 3721 and 3724.

"Indian Journal of Physics," Vol. 16, Part 6.

"Journal of Research" (National Bureau of Standards), Vol. 26, Nos. 1–2.

"Sky," Vol. 5, No. 6.

"Science and Culture," Vol. 6, No. 11.

"Sankhya," Vol. 5, No. 2.

"Indian Trade Journal," Vol. 140, Nos. 1816–20.

Books

"The Chemical Action of Ultra-Violet Rays," by Carleton Ellis and Alfred A. Wells. (Reinhold Publishing Co., N.Y.), 1941. Pp. 961. Price $12·00.

"Handbook of Economic Entomology for South India," by T. V. Ramakrishna Iyer. (Government Press, Madras), 1940. Pp. xviii + 528. Price Rs. 4–12.

"Canning Practice and Control," by Osman Jones and T. W. Jones. (Chapman & Hall, Ltd., London), 1941. Pp. xiv + 300. Price 32*s*.

ACADEMIES AND SOCIETIES

Indian Academy of Sciences: (*Proceedings*)

April 1941, SECTION A.—H. J. BHABHA: *Note on the correspondence between the classical and quantum theories of neutral mesons.* K. RANGANATHA RAO AND T. R. SESHADRI: *Synthesis of 7-hydroxy-5-methylcoumarin.* R. VENKATARAMAN: *The kinetics of the olefin-bromine reaction. Part III. A note on the influence of different catalysts on the reaction.* P. BHASKARA RAMA MURTI: *A study of the chemical components of the roots of* Decalepis Hamiltonii (*Makali Veru*). *Part II. A note on the preparation of inositol by solvent extraction.* S. BHAGAVANTAM AND J. BHIMASENACHAR: *Modified reflection of X-rays: Naphthalene.* Modified X-ray reflections due to (001), (002), and (201) planes of naphthalene have been recorded only when the crystal setting is very near that of the critical setting in each case. For orientations which differ appreciably from the above settings, the intensity of the modified spots appears to be very low. R. V. BHAT: *Adaptation of the micro-Kjeldahl method to the estimation of nitrogen in organic compounds containing nitro and azo groups.* (LATE) N. W. HIRWE AND B. V. PATIL: *Studies in chloral amides. Part VII. Reactivity of the α-OH group in chloral bromo salicylamides and their methyl ethers.* (LATE) N. W. HIRWE AND J. S. DESHPANDE: *Studies in chloral amides. Part VIII. Condensation of toluic amides with chloral.* (LATE) N. W. HIRWE AND J. S. DESHPANDE: *Studies in chloral amides. Part IX. Reactivity of α-chlorine in α-chloro-chloral toluic amides.* K. G. KRISHNAN: *Dispersion of ultrasonic velocity in organic liquids.* With seventeen organic liquids over the range 3500 kc to 8000 kc no

dispersion has been recorded. P. G. N. NAYAR: *Temperature variation of the Raman frequency of diamond.* Over the range of temperature −190° C. to 860° C. the characteristic Raman line varies from 1333·8 cm.$^{-1}$ to 1316 cm.$^{-1}$ From the thermodynamical relation between the thermal expansion of the crystal and the variation of the characteristic frequency, it has been found that the change observed is greater than that expressed. R. NORRIS: *The Raman spectrum and the specific heat of crystalline sulphur.* D. NARAYANAMURTI AND V. RANGANATHAN: *The thermal conductivity of Indian timbers. Part I. Variation of conductivity with density in the air-dry condition at ordinary temperature.* S. RNGASWAMI, T. R. SESHADRI AND V. VENKATESWARLU: *The remarkable fluorescence of certain coumarin derivatives.*

SECTION B.—T. S. RAGHAVAN AND V. K. SRINIVASAN: *Morphological and cytological studies in the scrophulariaceæ. Part IV. The development of the embryo-sac and endosperm in* Scoparia dulcis *Linn.* T. S. RAGHAVAN AND K. R. VENKATASUBBAN: *Studies in the capparidaceæ. VIII. The floral morphology of* Crataeva religiosa *Forst.* B. R. SESHACHAR: *The interstitial cells in the testis of* Ichthyophis glutinosus *Linn.* H. CHAUDHURI AND A. R. QURAISHI: *A study of the fungal endophyte of some* Anthoceros erectus *Kashyap.* M. SRINIVASAN, S. RAMASWAMY AND M. SREENIVASAYA: *A rapid method of determining peroxidase activity.*

Indian Association for the Cultivation of Science: (*Proceedings*)

December 1940.—G. N. BHATTACHARYA: *Specific heat of lac.* K. R. RAO AND M. G. SASTRY: *The first-spark spectrum of tellurium.* M. G. SASTRY: *Interferometric measurements of certain lines in the spectrum of bromine.* S. D. CHATTERJEE: *Study of thermal neutrons in the atmosphere.* L. D. MAHAJAN: *Adsorption of moisture from the moist air by the soils.* A. C. DEB: *Penetration of thin ionospheric layers.* B. N. SINGH: *Joule-Thomson and Joule effects for Bose-Einstein and Fermi-Diric gas.* M. GHOSH: *Dynamics of the pianoforte string and the hammer. Part IV (Study of duration of impact).* M. GHOSH: *Dynamics of the pianoforte string and the hammer. Part V (Some special theories).*

Meteorological Office Colloquium, Poona:

March 11, 1941.—B. N. DESAI: *Variation of lapse rate of temperature near the ground at Drigh Road, Karachi.*

March 18, 1941.—K. R. RAMANATHAN: *Atmospheric visibility.*

March 25, 1941.—P. R. CHIDAMBARA IYER: *Sunspots and prominences.*

Botanical Society of Bengal:

March 26, 1941.—G. P. MAJUMDAR: *On the origin of medullation in Selaginella.* A. K. GHOSH: *On the theoretical significance of bisporangiate sporophyll in* Lycopodium phlegmaria *Linn.*

Tin and Its Uses

The latest issue of the Tin Research Institute's Quarterly Review (No. 8) gives details of some improved pewter alloys containing over 90 per cent. of tin, which have all the merits of malleability and attractive sheen associated with the usual pewter alloys, but are substantially stronger. Spinning and other fabricating operations are as easily carried out as with ordinary pewter, but when finished articles of the new pewter are given a simple heat treatment; they develop 70 to 80 per cent. greater strength, and this strength is permanently retained in service conditions.

An announcement is made of the Institute's new booklet on Hot-Tinning (Publication 102), which describes the process as applied to cast iron, steels and alloy steels, copper and copper alloys, and shows how to overcome the difficulties which may arise.

An article on electro-tinning contrasts the old-fashioned stannous chloride bath with modern plating baths; it is shown that the former bath is of value only for producing very thin tin coatings of bright appearance, but modern baths will give tin coatings of any thickness desired, and so are of particular value for food processing equipment.

An article on opacifiers for vitreous enamels indicates that the special qualities of tin oxide have enabled it to maintain its position in the enamelling industry.

An example of the value of tin as a protective coating on steel is provided by its use in connection with the nitriding process, in which surfaces to be kept in an unhardened state are protected by a layer of tin. Nitriding is applied to cylinders, crankshafts, gears, shacklepins and valve sleeves for aero, automobile and Diesel engines as well as to textile, cement and plastic-moulding machinery.

Among the examples of the Institute's free Technical Service are particulars of a simple but sensitive chemical test for identifying tin in white-metal scrap, and of special tin solders which have higher melting points and greater strength than the usual tin-lead alloys.

ERRATA

Vol. 10, *No.* 4, *April* 1941:—

Contribution entitled "Cinchona Cultivation in India", page 223, para 2, line 8, *for* "21,00 lbs." *read* "210.000 lbs.".

Note entitled "Modified Equations for Adsorption and Base-Exchange in Soils", page 203, Table II, column 4, *for* $x = \frac{BU}{I+C'}$ *read* $x = \frac{BI}{I+C'}$;

Table II, column 5, the last but one value *for* 1·123 *read* 1·213.

614-41—Printed at The Bangalore Press, Bangalore City, by G. Srinivasa Rao, Superintendent, and Published by B. N. Sastri, M.Sc., A.I.C., A.I.I.Sc., for the Board of Editors, "Current Science", Bangalore.